IV. RESULTS

IV.1. Natural infection of the pink bollworm larvae with diseases and the role of mortality factors:

Larvae of P. gossypiella which were collected from 100 cotton bolls at different localities of four governorates were reared in the laboratory where mortalities among these larvae or the subsequent pupae were recorded. Dead larvae were examined, carefully, and subsequently divided according to the cause of death to determine the natural role played by bacteria, virus and other mortality factors in suppressing the larval population of P. gossypiella in Egyptian cotton fields. Data obtained at each of four governorates can be explained as follows :

IV.1.1. Fayoum Governorate :

Data recorded in Table (1) show the numbers and percentages of mortality among the pink bollworm larvae that collected from cotton bolls in fields of five localities at Fayoum governorate throughout the two successive seasons 1980 and 1981. In 1980; the percentages of larval mortality ranged between 9.25 % (at Sanoris) and 13.45 % (at Abshway) with an average of 12.04 %. In 1981 season; these

percentages were 7.14 - 13.93 % at Tamyia and Atsa, respectively (average 11.36 %). Mortalities among pupae that developed from the collected larvae ranged from 4.98 % (at Sanoris) to 29.27 % (at Tamyia) with an average of 17.54 % in 1980 and from 6.32 % (at Abshway) to26.02 (at Tamyia) (average 13.4 %) in 1981. The percentages of adults that resulted from the collected larvae averaged 70.42 % (57.32 % at Tamyia-85.77 % at Sanoris in 1980, and 75.24 % (66.84 % at Tamyia-82.76 % at Abshway in 1981) (Table, 24). The total mortality percentage averaged 29.58 % in 1980 (14.23 at Sanoris to 42.68 % at Tamyia) and 24.76 in 1981 (17.24 at Abshway to 33.16 % at Tamyia), thus indicating the highest total mortality percentages at Tamyia in both seasons.

As shown in Table (1); from a total of 2907 larvae collected in both seasons at Fayoum governorate, 340 (11.7 %) died in the larval stage, 449 (15.44 %) died in the pupal stage and the remaining 2118 (72.86 %) developed into normal pupae and emerged, subsequently, into adults.

Investigating the role played by different factors causing mortality amongst the dead larvae (Table, 2); mortalities due to bacteria ranged between 43.18 % (at Atsa) and 73.08 % (at Sanoris).

Table (1) : Numbers and percentages of mortality among larvae and subsequent pupae of P.gossypiella collected from green cotton bolls at different districts of Fayoum governorate.

Season	Locality	No. of inspected bolls	No. of counted larvae	Dead larvae No.	Dead larvae %	Normal pupae No.	Normal pupae %	Dead pupae* No.	Dead pupae* %
1980	Fayoum	300	323	38	11.76	211	65.33	74	22.91
	Atsa	300	349	44	12.61	242	69.34	63	18.05
	Sanoris	300	281	26	9.25	241	85.77	14	4.98
	Abshway	300	238	32	13.45	177	74.37	29	12.18
	Tamyia	300	246	33	13.41	141	57.32	72	29.27
	Overall	1500	1437	173	12.04	1012	70.42	252	17.54
1981	Fayoum	300	267	30	11.24	205	76.78	32	11.98
	Atsa	300	366	51	13.93	269	73.50	46	12.57
	Sanoris	300	293	34	11.60	213	72.70	46	15.70
	Abshway	300	348	38	10.92	288	82.76	22	6.32
	Tamyia	200	196	14	7.14	131	66.84	51	26.02
	Overall	1400	1470	167	11.36	1106	75.24	197	13.40
Overall for two seasons		2900	2907	340	11.70	2118	72.86	449	15.44

* Pupae that did not develop into adults.

Table (2) : The role of different factors causing mortality of the pink bollworm larvae in cotton fields at different districts of Fayoum governorate.

Season	Locality	Total No. of dead larvae	Mortalities due to different causes							
			Bacteria		Virus		Natural mortality		Other factors	
			No.	%	No.	%	No.	%	No.	%
1980	Fayoum	38	20	52.63	11	28.95	4	10.53	3	7.89
	Atsa	44	19	43.18	15	34.09	2	4.55	8	18.18
	Sanoris	26	19	73.08	1	3.85	0	0.00	6	23.08
	Abshway	32	15	46.88	5	15.63	2	6.25	10	31.25
	Tamyia	33	19	57.58	7	21.21	0	0.00	7	21.21
	Overall	173	92	53.18	39	22.54	8	4.62	34	19.65
1981	Fayoum	30	16	53.33	7	23.33	0	0.00	7	23.33
	Atsa	51	36	70.59	9	17.65	1	1.96	5	9.80
	Sanoris	34	26	76.47	6	17.65	1	2.94	1	2.94
	Abshway	38	23	60.53	5	13.16	5	13.16	5	13.16
	Tamyia	14	11	78.57	0	0.00	1	7.14	2	14.29
	Overall	167	112	67.07	27	16.17	8	4.79	20	11.98
Overall of two seasons		340	204	60.00	66	19.41	16	4.71	54	15.88

Table (3) : Numbers and percentages of mortality among larvae and subsequent pupae of P.gossypiella collected from green cotton bolls at different districts of Qalubia governorate.

Season	Locality	No. of inspected bolls	No. of counted larvae	Dead larvae No.	Dead larvae %	Normal pupae No.	Normal pupae %	Dead pupae No.	Dead pupae %
1980	Banha	400	304	49	16.12	227	74.67	28	9.21
	Kanater El-Khayria	200	231	12	5.19	148	64.07	71	30.74
	Toukh	200	210	14	6.67	150	71.42	46	21.90
	Overall	800	745	75	10.07	525	70.47	145	19.46
1981	Banha	300	113	20	17.70	87	76.99	6	5.31
	Kanater El-Khayria	200	99	17	17.17	68	68.69	14	14.14
	Overall	500	212	37	17.45	155	73.11	20	9.43
Overall for two seasons		1300	957	112	11.70	680	71.06	165	17.24

mortality in the pupal stage (30.74 %) occurred at Kanater El-Khayria (Table, 3). In 1981 cotton season; counts were made on larvae collected from Banha and Kanater El-Khayria fields (113 and 99 larvae, respectively). From these larvae; 20 (17.7%) and 17 (17.17 %) died in the larval stage, and 6 (5.31 %) and 14 (14.14 %) died in the pupal stage, while the remaining 87 (76.99 %) and 68 (68.69 %) larvae developed normally until the adult stage.

In both seasons; a total of 957 P. gossypiella larvae were collected at Qalubia governorate. From these larvae; 112 (11.70 %) died in the larval stage, 165 (17.24%) died in the pupal stage and 680 (71.06 %) developed until the adult stage (Table, 3).

Amongst the dead larvae; the highest percentage of mortality due to bacteria in 1980 (85.71 %) occurred at Toukh district, while in 1981 the bacterial diseases were responsible for mortality of 90 % of the dead larvae at Banha (Table, 4). The highest percentage mortality due to viral diseases (50 %) occurred at Kanater El-Khayria in 1980. The percentages kill at Qalubia governorate (amongst dead larvae) by bacteria, virus, other factors and natural

Table (4) : The role of different factors causing mortality of the pink bollworm larvae in cotton fields at different districts of Qalubia governorate.

Season	Locality	Total No. of dead larvae	Mortalities due to different factors							
			Bacteria		Virus		Natural mortality		Other factors	
			No.	%	No.	%	No.	%	No.	%
1980	Banha	49	13	26.53	9	18.37	12	24.49	15	30.61
	Kanater El-Khayria	12	6	50.00	6	50.00	0	0.00	0	0.00
	Toukh	14	12	85.71	1	7.14	1	7.14	0	0.00
	Overall	75	31	41.33	16	21.33	13	17.33	15	20.00
1981	Banha	20	18	90.00	0	0.00	2	10.00	0	0.00
	Kanater El-Khayria	17	11	64.71	1	5.88	3	17.65	2	11.76
	Overall	37	29	78.38	1	2.70	5	13.51	2	5.41
Overall for two seasons		112	60	53.57	17	15.18	18	16.07	17	15.18

mortality were 41.33, 21.33, 20 and 17.33 % in 1980, and 78.38, 2.7, 5.41 and 13.51 % in 1981, respectively (Table, 4). Data on both seasons (Table, 4) show that from the 112 dead P. gossypiella larvae that resulted from larvae collected from cotton fields at Qalubia governorate; 60 (53.57 %) died by bacteria, 17 (15.18 %) by virus, 17 (15.18 %) by the other factors and the remaining 18 (16.07 %) by natural mortality.

IV.1.3. Sharkyia Governorate :

Samples were obtained from Zagazig, Mashtoul, Menia El-Kamh and Kenayat in 1980, and from the same localities except Kenayat in 1981. Percentages of larval mortality in 1980 ranged from 10.49 % (at Zagazig) to 18.71 % (at Mashtoul) with an average of 15.22 %. In 1981 season; the percentages of larval mortality at Zagazig, Mashtoul and Menia El-Kamh were 8.53, 4.44 and 7.8 %, respectively with an average of 6.91 % (Table, 5). The average mortality percentages in the pupal stage were 19.16 % in 1980 (13.77 % at Zagazig to 24.46 % at Mashtoul) and 13.58 % in 1981 (10.85, 11.11 and 18.44 % at Zagazig, Mashtoul and Menia El-

Table (5) : Numbers and percentages of mortality among larvae and subsequent pupae of P.gossypiella collected from different localities at Sharkyia governorate.

Season	Locality	No. of inspected bolls	No. of counted larvae	Dead larvae No.	Dead larvae %	Normal pupae No.	Normal pupae %	Dead pupae No.	Dead pupae %
1980	Zagazig	400	305	32	10.49	231	75.74	42	13.77
	Mashtoul	300	278	52	18.71	158	56.83	68	24.46
	Menia El-Kamh	400	251	40	15.94	168	66.93	43	17.13
	Kenayat	300	257	42	16.34	159	61.87	56	21.79
	Overall	1400	1091	166	15.22	716	65.63	209	19.16
1981	Zagazig	300	129	11	8.53	104	80.62	14	10.85
	Mashtoul	300	135	6	4.44	114	84.44	15	11.11
	Menia El-Kamh	200	141	11	7.80	104	73.76	26	18.44
	Overall	800	405	28	6.91	322	79.51	55	13.58
Overall for two seasons		2200	1496	194	12.97	1038	69.39	264	17.65

Kamh, respectively) (Table, 5). Data in Table (5) indicate that mortalities amongst larvae and pupae in 1980 (15.22 and 19.16 %) were higher than those occurred in 1981 (6.91 and 13.58, respectively). From the 1496 P. gossypiella larvae that collected from Sharkyia governorate in both seasons; 194 (12.97 %) died in the larval stage, 264 (17.65 %) died in the pupal stage, while the remaining larvae (1038, i.e.; 69.39 %) normally transferred into pupae and, subsequently, into adults (Table, 5).

With regard to the different factors causing mortality, among the dead larvae, it was found that bacteria were more responsible, in both seasons, for larval mortality than virus and other mortality factors (Table, 6). In 1980; an average percentage of 52.41 % of the dead larvae (minimum of 34.38 % at Zagazig and maximum of 61.9 % at Kenayat) were found infected by bacteria. In 1981; bacteria were responsible for mortality of 54.55, 33.33 and 100 % (average 67.86 %) of the dead larvae at Zagazig, Mashtoul and Menia El-Kamh, respectively. Virus caused 5.77 % (at Mashtoul) to 22.5 % (at Menia El-Kamh) of mortalities in 1980 (average 14.46 %). In

Table (6) : The role of different factors causing mortality of P. gossypiella larvae in cotton fields at different districts of Sharkyia governorate.

Season	Locality	Total No. of dead larvae	Mortalities due to different factors							
			Bacteria		Virus		Natural mortality		Other factors	
			No.	%	No.	%	No.	%	No.	%
1980	Zagazig	32	11	34.38	5	15.63	7	21.88	9	28.13
	Mashtoul	52	30	57.69	3	5.77	7	13.46	12	23.08
	Menia El-Kamh	40	20	50.00	9	22.50	5	12.50	6	15.00
	Kenayat	42	26	61.90	7	16.67	0	0.00	9	21.43
	Overall	166	87	52.41	24	14.46	19	11.45	36	21.69
1981	Zagazig	11	6	54.55	3	27.27	0	0.00	2	18.18
	Mashtoul	6	2	33.33	0	0.00	4	66.67	0	0.00
	Menia El-Kamh	11	11	100.00	0	0.00	0	0.00	0	0.00
	Overall	28	19	67.86	3	10.71	4	14.29	2	7.14
Overall for two seasons		194	106	54.64	27	13.92	23	11.86	38	19.59

1981, the respective percentages of mortality among dead larvae, due to viral diseases, were 27.27, 0 and 0 % with an average of 10.71 %. These data indicate higher role played by bacteria in 1981, and by virus in 1980. The other mortality factors caused the averages of 21.69 and 7.14 % of mortalities in 1980 and 1981, respectively, while the respective percentages of natural mortality were 11.45 and 14.29% (Table, 6). A total number of 194 dead P.gossypiella larvae were counted in both seasons at Sharkyia governorate, the percentages of different factors causing mortality were 54.64, 13.92, 19.59 and 11.86 % for bacteria, virus, other factors and natural mortality, respectively (Table, 6).

IV.1.4. Gharbyia Governorate :

The total numbers of 267 and 166 larvae were counted in bolls from cotton fields at Zephta (Gharbyia governorate) in 1980 and 1981 seasons, respectively. From these larvae; 37 and 34 (13.86 and 20.48 %) died in their larval stage, 44 and 17 (16.48 and 10.24 %) died after being transferred into pupae, while the remaining larvae (186 and 115,

i.e.; 69.66 and 69.28 %, respectively) developed normally until reaching the adult stage. The averages in the percentage mortality in both seasons were 16.4% (71 larvae) in the larval stage and 14.09 % (61 pupae) in the pupal stage (Table, 7).

From the 37 dead larvae of 1980 cotton season; mortality of 29 larvae (78.38 %) was attributed to bacterial diseases, 3 (8.11 %) to virus, and the remaining 5 larvae (13.51 %) to natural mortality. In 1981; mortality of 28 larvae (82.35 % of the dead larvae) was due to bacteria, 3 (8.82 %) to factors other than bacteria and virus and the remaining 3 larvae to natural mortality. No dead larva was found infected by virus in 1981 (Table, 8). The total number of dead larvae counted in both seasons was 71, of which 57 (80.28 %) died by bacteria, 3 (4.23 %) by virus, 3 larvae (4.23)by other factors, and mortality of the remaining 8 larvae (11.27 %) was attributed to natural mortality (Table, 8).

IV.2. Mortalities amongst collected P.gossypiella larvae and general estimation of the role played by different factors causing mortality at four Egyptian governorates :

Table (7) : Numbers and percentages of mortality among larvae and subsequent stages of P. gossypiella collected from green bolls in 1980 and 1981 cotton seasons at Zephta (Gharbyia governorate).

Season	No. of inspected bolls	No. of counted larvae	Dead larvae No.	Dead larvae %	Normal pupae No.	Normal pupae %	Dead pupae No.	Dead pupae %
1980	300	267	37	13.86	186	69.66	44	16.48
1981	300	166	34	20.48	115	69.28	17	10.24
Overall	600	433	71	16.40	301	69.52	61	14.09

Table (8) : The role of different factors causing mortality of the pink bollworm larvae in cotton fields at Zephta (Gharbyia governorate).

Season	Total No. of dead larvae	Mortalities due to different causes							
		Bacteria		Virus		Natural mortality		Other factors	
		No.	%	No.	%	No.	%	No.	%
1980	37	29	78.38	3	8.11	5	13.51	0	0
1981	34	28	82.35	0	0.00	3	8.82	3	8.82
Overall	71	57	80.28	3	4.23	8	11.27	3	4.23

Data illustrated in Fig. (4) show that in 1980 cotton season; the highest percentage mortality in the larval stage (15.22 %) occurred at Sharkyia governorate, and the lowest percentage (10.11 %) was recorded at Qalubia governorate. Amongst the subsequent pupae; the highest percentage mortality (19.54%) was recorded at Qalubia, while the lowest percentage (16.48 %) could be detected at Gharbyia governorate. An inverse relationship could be detected between the total mortality percentage (Fig. 4) and the pink bollworm larval population (Part IV.1). In 1980, the highest total mortality percentage (34.38 %) occurred at Sharkyia governorate where the lowest population of larvae (77.93 larvae/100 bolls) was recorded. The lowest total mortality percentage (29.58 %) that recorded at Fayoum (Fig. 4) was, on the other hand, associated with the highest population of larvae (95.5 larvae per 100 bolls) recorded at the same governorate. In 1981 cotton season, the same trend could be detected where the highest population of P. gossypiella larvae that recorded at Fayoum governorate (105 larvae/100 bolls) was assciated with lower percentage of total mortality (24.76 %), while the highest total mortality percentage (30.72 %) that

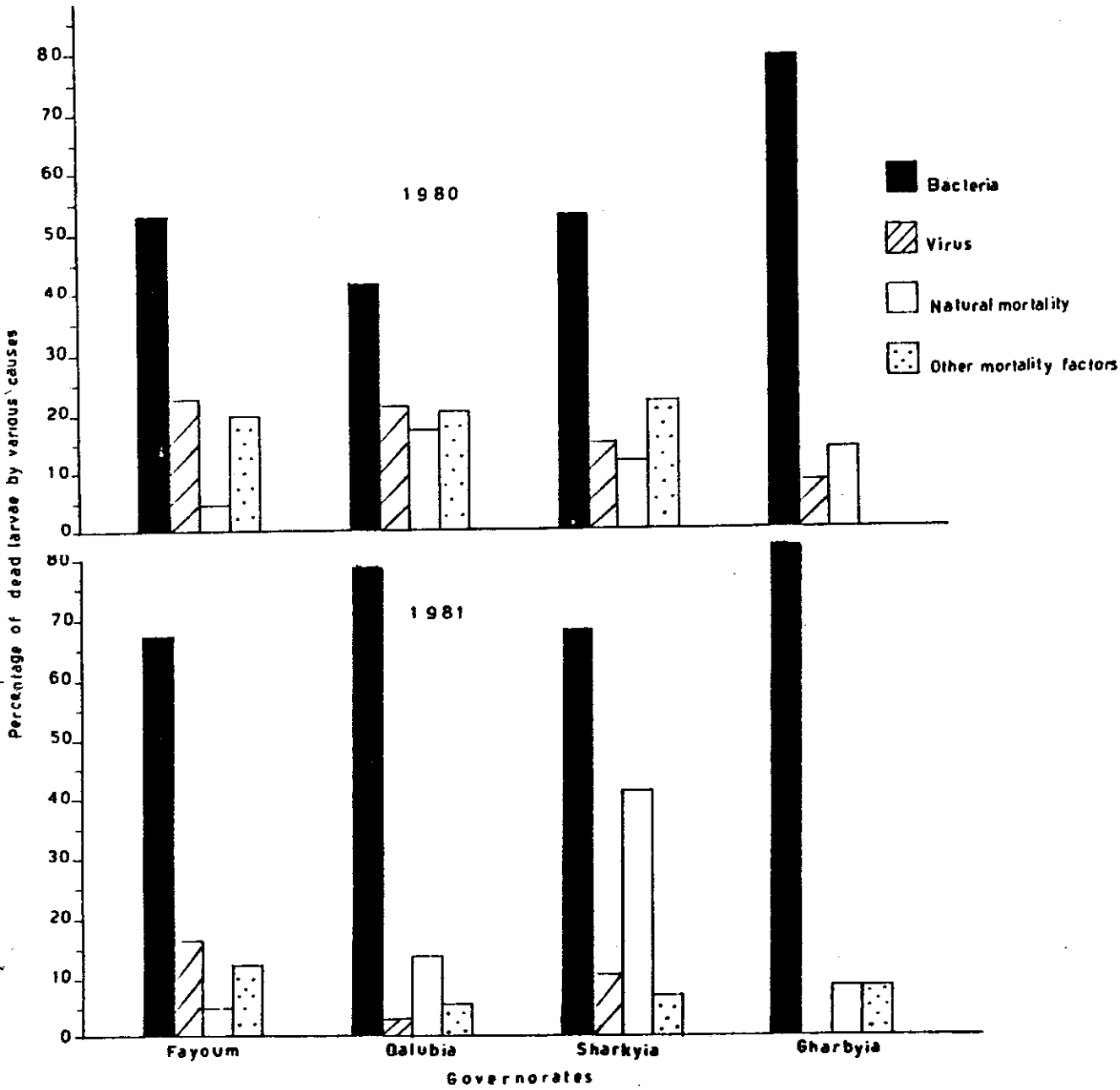

Fig.(5)_ Percentages mortality among pink bollworm larvae by various causes at four governorates, during two successive seasons, 1980 and 1981.

recorded at Gharbyia governorate (Fig. 4) was associated with lower population of larvae (55.33 larvae/100 bolls) recorded at the same governorate.

From data illustrated in (Fig. 5) it could be concluded that in all of four governorates, bacteria played the main natural role in suppressing the population of active larvae under field conditions where mortalities by bacteria, in all cases, caused the highest percentage of larval mortality. The highest role played by bacteria was recorded amongst larvae collected from Gharbyia governorate in both 1980 and 1981 cotton seasons, followed by Fayoum, Sharkyia and Qalubia in 1980 and by Qalubia, Sharkyia and Fayoum in 1981 (Fig. 5). Virus ranked the second, after bacteria, in causing mortality at Fayoum governorate in both seasons and at Qalubia in 1980. The descending order in percentages mortality, due to viral diseases, at four governorates was Fayoum in both seasons followed by Qalubia, Sharkyia and Gharbyia in 1980 and by Sharkyia, Qalubia and Gharbyia in 1981. Thus indicating the lowest efficiency of virus on P. gossypiella larvae, in both seasons, at Gharbyia governorate (Fig. 5). The other mortality factors manifested their highest efficiency in 1980 at

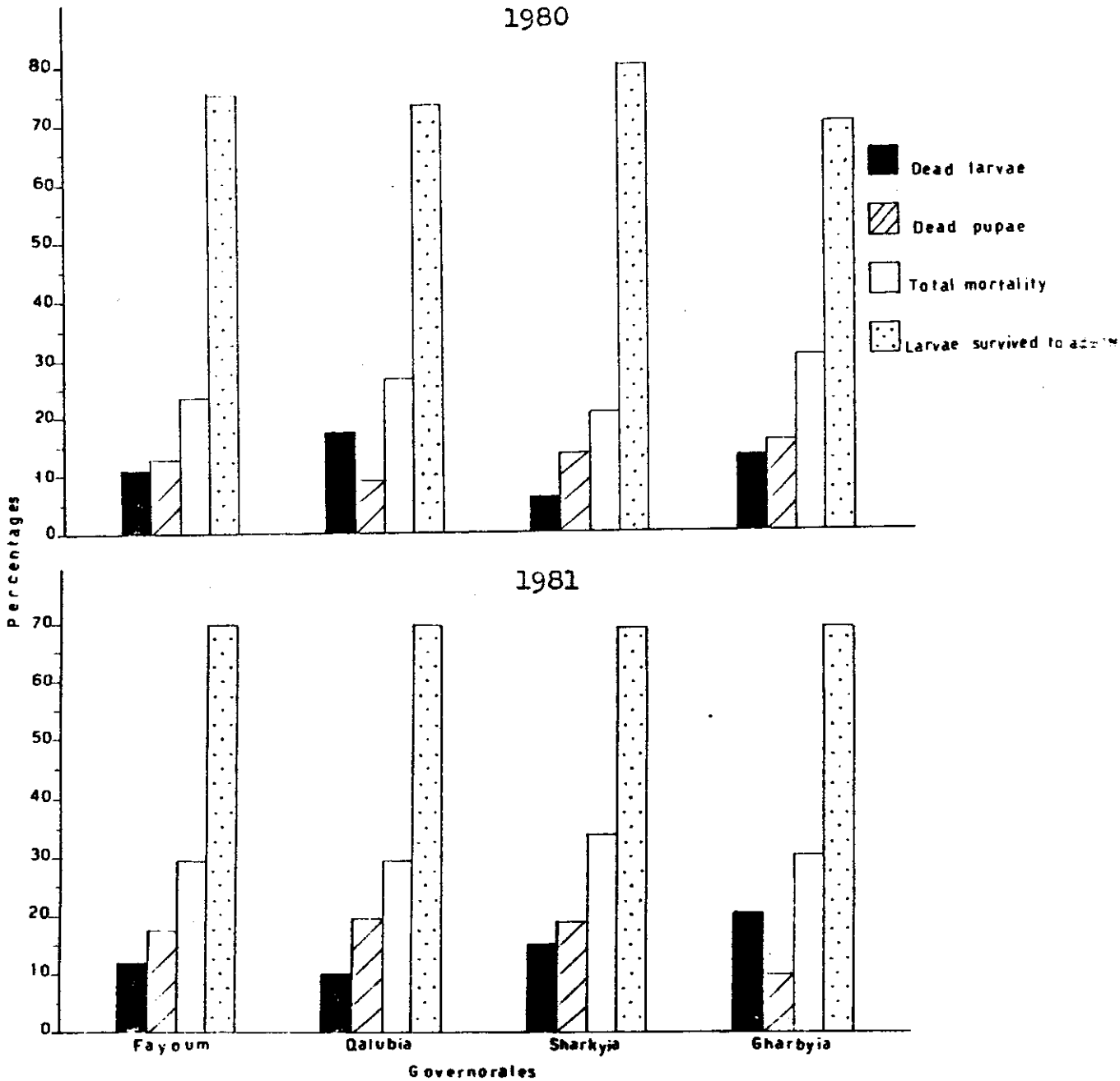

Fig.(4)_ Percentages of mortality amongst P. gossypiella larvae collected from fields of four Egyptian governorates.

Sharkyia followed by Qalubia and Fayoum, and their lowest efficiency at Gharbyia. In 1981; the descending order in percentages mortality, due to factors other than bacteria and virus, was Fayoum, Gharbyia, Sharkyia and Qalubia. Natural mortality was highest at Qalubia governorate, followed by Gharbyia, Shar-Kyia and Fayoum in 1980 and at Sharkyia, followed by Qalubia, Gharbyia and Fayoum in 1981 (Fig.5). Thus indicating the lowest percentages of natural mortality, in both seasons, at Fayoum governorate.

IV.3. Laboratory infectivity tests with Bacillus thuringiensis Ber. :

IV.3.1. Effect on larvae of Earias insulana :

Data recorded in Table (9) show the percentages mortality of the spiny bollworm larvae after different periods of feeding, directly after hatching, on okra fruit disks treated with 4 concentrations of B. thuringiensis spores suspension of each of the two commercial products; Bactospeine and Dipel. These data indicated that the 1st instar larvae of E.insulana were susceptible to bio-insecticidal treatment. The corrected percentages of mortality in case of feeding for 5 days on disks treated with the lowest concentration (0.05 %; 8 x 10^3 I.U./ml. suspension) were 22.58 and 29.03 % in case of Bactospeine and Dipel, respectively. Feeding on disks treated with the highest concentration (0.4 %; 64 x 10^3 I.U./ml. suspension) for the same period caused, on the other hand, the highest percentages of mortality (61.29 and 64.52 % in case of Bactospeine and Dipel, respectively).

After 7 days of treatment; another group of the spiny bollworm larvae died but, as shown in Table (9),

Table (9) : Corrected percentages of mortality among spiny bollworm larvae fed, after hatching, on food treated with suspensions of two commercial products of B. thuringiensis (Data from 40 larvae in each treatment).

Treatment	Concentration (I.U./ml. suspension)	Periods(/days) after 5	7	10	No. of surviving larvae
Bactospeine	8×10^3	22.58	35.71	42.86	16
	16×10^3	41.93	50.00	50.00	14
	32×10^3	41.93	60.71	60.71	9
	64×10^3	61.29	67.86	71.73	8
Dipel	8×10^3	29.03	50.00	50.00	14
	16×10^3	45.16	50.00	57.14	12
	32×10^3	48.39	50.00	67.86	9
	64×10^3	64.52	71.43	71.43	8

N.B. Percentages mortality in control were 22.5, 30 and 30 % after 5, 7 and 10 days, respectively.

the mortality rates were greatly lower than those occurred after 5 days of treatment. The percentages of mortality ranged from 35.71 to 67.86 % in case of Bactospeine treatment and from 50.0 to 71.43 % in case of treatment with Dipel. No further effect could be detected, on the other hand, after 10 days of treatment (Table, 9).

The concentration-mortality line is graphically plotted in Fig. (6) indicating a direct relationship between the mortality rate and the applied concentration, i.e.; the percentage of mortality increases as the number of B. thuringiensis spores applied to the larval food increased. Data in this graph and those recorded in Tables (10& 11)indicate that the LC_{50} after 7 days of treatment was 0.1 %, i.e., 16.5 x 10^3 I.U./ml. suspension (with the confidence limits of 0.06 - 0.18 % at 95 % probability) in case of Bactospeine and 0.07 (0.01 - 0.52 %) in case of Dipel.

The LT_{50} (time required for mortality of 50 % of treated larvae) was calculated for each of the applied concentrations, and the values are recorded in Table (12) These data, clearly, show a negative relationship between the concentration and the LT_{50}

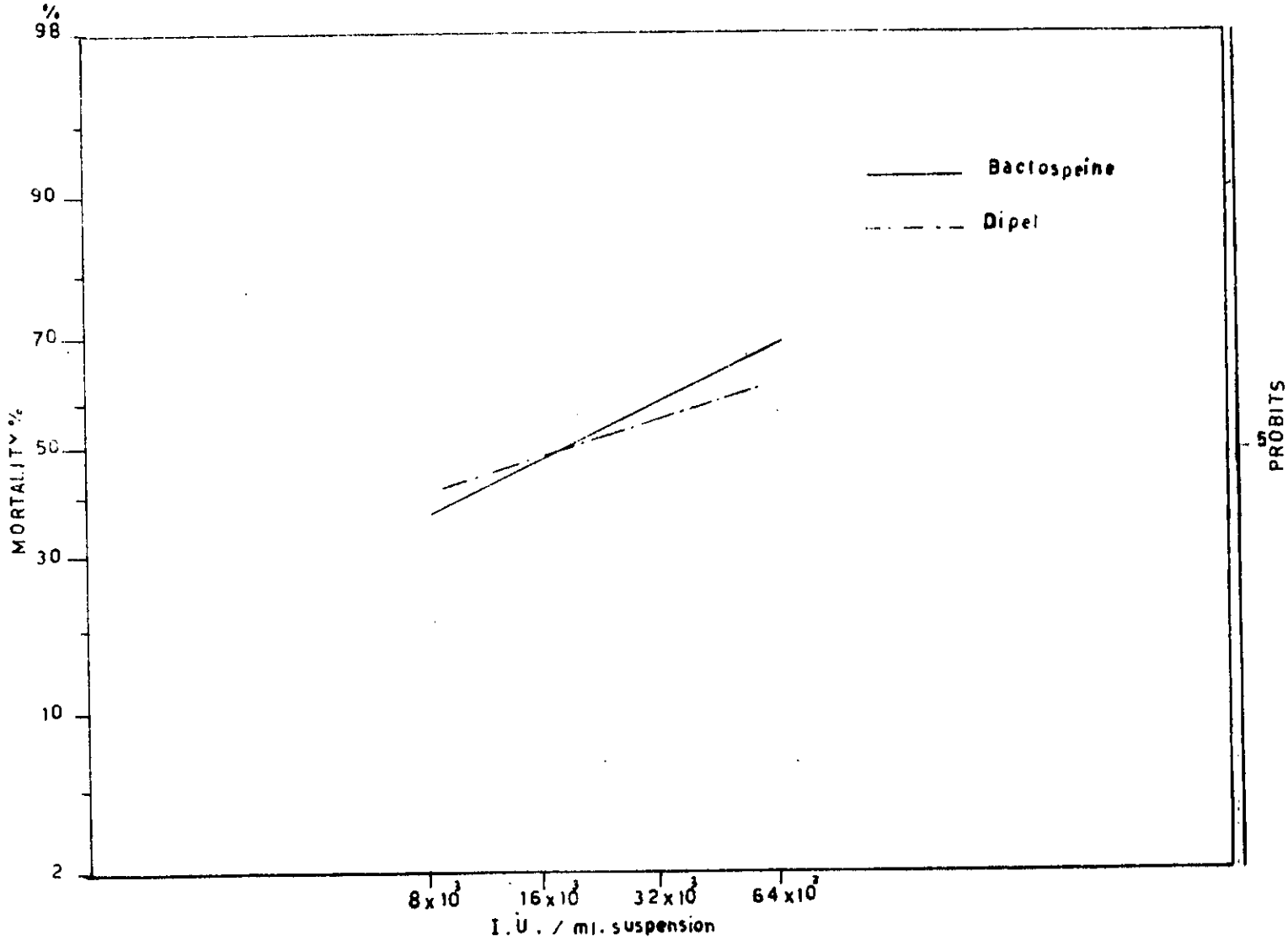

Fig.(6)- Log.conc probit lines showing percentages mortality among the spiny bollworm larvae fed, for 7 days after hatching on okra pod disks treated with two bio.insecticides of B. thuringiensis.

Table (10): Percentages mortality of E. insulana larvae fed, for 7 days, on okra disks contaminated with Bactospeine suspensions.
(Experiments were carried out on 40 newly hatched larvae).

Concentration (%)	% of observed mortality	Expected mortality % (from graph)	Obs.-Exp.	Contribution to Chi^2
0.05 (8×10^3 I.U./ml.)	35.71	39.0	- 3.29	0.0045
0.10 (16×10^3 I.U./ml.)	50.0	50.0	0.00	0.0000
0.20 (32×10^3 I.U./ml.)	60.71	60.0	0.71	0.0002
0.40 (64×10^3 I.U./ml.)	67.8	70.0	- 2.20	0.0022
Total Chi^2				0.0069

Experimental Chi^2 = 0.276

Tabulated Chi^2 = 5.991

x Data are not significantly heterogeneous.

The slope = 0.8895

LC_{50} = 0.1023 % (16.5×10^3 I.U./ml. suspension).

Confidence limits of LC_{50} (at 95 % probability).

Upper = 0.178 % (28.4×10^3 I.U./ml.)

Lower = 0.059 % (9.4×10^3 I.U./ml.)

Table (11): Percentages of larval mortality of E.insulana fed for 7 days on disks treated with Dipel suspension (Fourty newly emerged larvae were tested.

Concentration %	% of corrected mortality (observed)	% of expected mortality (from graph)	Obs.-Exp.	Contribution to Chi^2
0.05	50.0	43	7	0.02
0.10	50.0	50	0	0.00
0.20	50.0	57	7	0.02
0.40	71.43	63	8.43	0.03
Total Chi^2				0.07

Experimental Chi^2 = 2.80

Tabulated Chi^2 = 5.99

* Data are not significantly heterogenous.

The slope = 0.304

LC_{50} = 0.0675 (10.8 x 10^3 I.U./ml. suspension)

Confidence limits of LC_{50} (at 95 % probability).

Upper = 0.52 (83.2 x 10^3 I.U./ml.).

Lower = 0.009(1.4 x 10^3 I.U./ml.).

Table (12): The LT_{50} values of Bactospeine and Dipel when 40 newly hatched larvae of E. insulana were fed on treated okra pod disks.

Concentration	LT_{50} (in days)	
(%)	Bactospeine	Dipel
0.05	11.97	9.48
0.10	7.94	6.66
0.20	5.92	6.15
0.40	2.30	1.31

value, where these values decreased as the applied dose increased. The LT_{50} ranged from 2.3 to 11.97 days and 1.31 to 9.48 days for treatment with Bactospeine and Dipel, respectively (Table,12).

As shown in Table (13) the surviving larvae reached the pupal stage, but few number of the obtained pupae were malformed. Percentages of malformed pupae were 12.5, 0.0, 11.11 and 12.5 % in case of Bactospeine treatments, while those noticed when food was dipped in Dipel suspensions were 7.14, 16.67, 0.0 and 25 % for the concentrations 0.05, 0.1, 0.2 and 0.4 %, respectively. Malformed pupae, in all cases, did not develop into adults, while the normal ones that obtained from larvae fed on treated food, normally, emerged into adults.

IV.3.2. Tests against active larvae of P.gossypiella:

IV.3.2.1. Effect on newly hatched larvae :

The corrected percentages of mortality among larvae of P. gossypiella, when left (after hatching) to infest cotton bolls dipped in 0.05, 0.1, 0.2 and 0.4 % water suspensions of the bio-insecticide of B. thuringiensis spores (Bactospeine), are shown in

Table (13) : Numbers and percentages of pupae (normal and malformed) and emerged adults of E. insulana that resulted from 40 newly hatched larvae fed on okra pod disks contaminated with different concentrations of two bio-insecticides of B. thuringiensis spores.

Treatment	Concentration (%)	No. of obtained pupae	Percentage of		
			Normal pupae	Malformed pupae	Adults emerged from normal pupae
Bactospeine	0.05	16	87.5	12.5	100
"	0.01	14	100.0	0.0	100
"	0.20	9	88.89	11.11	100
"	0.40	8	87.50	12.5	100
Control	-	28	100.00	0.0	100
Dipel	0.05	14	92.86	7.14	100
"	0.10	12	83.33	16.67	91.67
"	0.20	9	100.00	0.00	100
"	0.40	8	75.00	25.0	100
Control	-	27	100.00	0.0	100

N.B. Malformed pupae died before being transferred into adults.

Table (14). The observed corrected larval mortality ranged from 33.33 to 63.33 %; 37.04 to 62.96 % and 34.61 to 69.2 % after 5, 7 and 10 days of feeding on treated bolls, respectively, depending on the used concentration.

The obtained data (Table, 14) showed that after 5 days of treatment; the three lower concentrations (0.05, 0.1 and 0.2 %) were, nearly, of the same effect (33.33, 36.67 and 36.67 % mortality, respectively), while the highest concentration (0.4 %) showed the highest efficiency (63.44 % mortality). After 7 and 10 days of treatment; the effect was, on the other hand, a concentration dependent, where the percentage of observed mortality increased with the increase of the applied dose.

Treatment of cotton bolls with the lowest and highest concentrations (0.05 and 0.4 %) caused 33.33 % and 63.33 % mortality among exposed larvae after 5 days of treatment, respectively. During the following 5 days(after 7 and 10 days of treatment) no further, noticeable, mortalities were recorded. At the two intermediate concentrations (0.1 and 0.2 %) an increasing effect was recorded as the period after treatment

Table (14) : Corrected percentages of mortality among the newly hatched larvae of pink bollworm when left to infest cotton bolls treated with Bactospeine suspensions (40 newly hatched larvae/treatment).

Concentration (%)	Days after treatment		
	5	7	10
0.05 (8 x 10^3 I.U./ml.)	33.33	37.04	34.61
0.10 (16 x 10^3 I.U./ml.)	36.67	44.44	50.00
0.20 (32 x 10^3 I.U./ml.)	36.67	51.85	61.50
0.40 (64 x 10^3 I.U./ml.)	63.33	62.96	69.20

N.B. Percentages mortality in control were 25, 32.5 and 35 % after 5, 7 and 10 days, respectively.

increased (percentages mortality were 36.67, 44.44 and 50.0 % for 0.1 % treatment and 36.67, 51.85 and 61.5 % for 0.2 treatment, after 5, 7 and 10 days of treatment, respectively).

The log. concentration probit line is graphically illustrated in Fig. (7). The recorded data in this figure showed that the LC_{50} of Bactospeine on the first instar larvae of P. gossypiella, after 7 days of treatment, was 0.15 % (24 x 10^3 I.U./ml. suspension). Calculations of the confidence limits of LC_{50} (Table, 15) showed that it ranged from 0.08 to 0.28 % (13.1 x 10^3 - 44.8 x 10^3 I.U./ml. suspension).

Calculated values of LT_{50} for the effect of different concentrations of Bactospeine on the newly hatched pink bollworm larvae showed that the lowest concentration (0.05 %) was inefficient, while these values were 9.87, 6.97 and 1.47 days for the concentrations of 0.1, 0.2 and 0.4 %, respectively.

The remainder larvae, of these fed on contaminated bolls and control, were allowed to pupate under laboratory conditions, and the data on the failure of pupation among these larvae and that of adults emergence

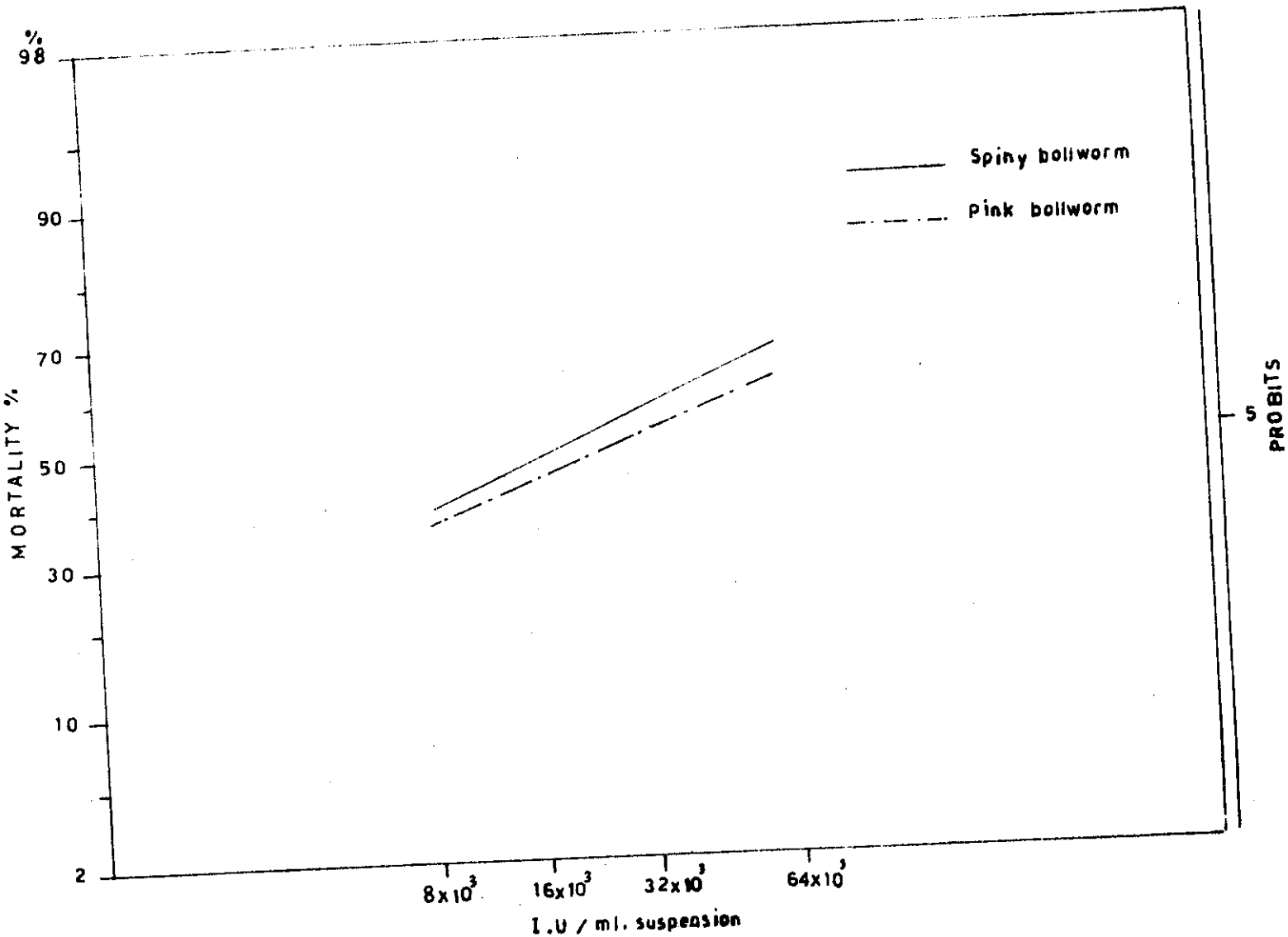

Fig.(7)_Log. con. probit line showing the effect of treatment of cotton bolls in Bactospeine suspensions on the newly hatched larvae of pink and spiny bollworms after 7 days of treatment.

Table (15) : Percentages of mortality in pink bollworm larvae fed after hatching on cotton bolls, contaminated with Bactospeine suspensions, for 7 days (Data from 40 larvae/treatment).

Concentration (%)	Corrected mortality % (observed)	Expected mortality % (from graph)	Obs - Exp.	Contribution to Chi^2
0.05	37.04	36	1.04	0.0005
0.10	44.44	45	- 0.56	0.0001
0.20	51.85	53	- 1.15	0.0005
0.40	62.96	62	0.96	0.0004
Total Chi^2				0.0015

Experimental Chi^2 = 0.056

Tabulated Chi^2 = 5.991

∴ Data are not significantly heterogeneous.

The slope = 0.735

LC_{50} = 0.152 % (24 x 10^3 I.U./ml. suspension).

Confidence limits of LC_{50} (at 95 % probability) :

Upper = 0.28 % (44.8 x 10^3 I.U./ml.).

Lower = 0.082 % (13.1 x 10^3 I.U./ml.).

among the obtained pupae are recorded in Table (16). As shown in this table; the percentage failure in pupation was, considerably, higher among larvae that fed on contaminated food than those of the control. This percentage ranged between 13.33 - 25.0 % depending on the concentration of the bio-insecticide suspension.

As shown in Table (16); the percentage of adults emergence, from normal pupae, was not affected in case of pupae from the control larvae and those obtained from larvae fed on cotton bolls treated with the lowest concentration (0.05 %) of Bactospeine suspension, this percentage was affected when cotton bolls were contaminated with higher concentrations (0.1, 0.2 and 0.4 %) where the percentages of failure in adults emergence within the normal pupae were 20, 12.5 and 50 %, respectively.

IV.3.2.2. Effect on the second and fourth instar larvae :

The purpose of this test was to determine the effect of surface contamination of the nutrient artificial diet on the pink bollworm larvae, and subsequent instars, when the 2nd and 4th instars of

Table (16) : Failure of pupation and adult emergence when newly hatched larvae of P.gossypiella were fed on cotton bolls dipped in Bactospeine suspensions (Data from 40 treated larvae).

Concentration (%)	No. of larvae immediately before pupation	% Failure of	
		Pupation among surviving larvae	adult emergence among normal pupae
0.05	15	13.33	0.0
0.10	13	23.08	20.0
0.20	10	20.00	12.5
0.40	8	25.00	50.0
Control	26	3.85	0.0

these larvae were allowed to feed on this diet. The obtained data showed that the corrected percentages of mortality, in case of the second instar treatment, ranged from 15.79 to 57.89 % after 24 hours of treatment, 29.41 to 82.35 % after 48 hours and 29.41 to 82.35 % after 72 hours of treatment. However; feeding of the fourth instar larvae on contaminated medium caused mortalities ranged from 15.79 to 42.11 after 24 hours, 16.67 - 50.0 % after 48 hours and 22.22 to 55.56 % after 72 hours of treatment, respectively (Table, 17). As shown in the mentioned table; the larval mortality rate augmented as the applied dose of B. thuringiensis spores, added to the surface of the nutrient diet increased. The prolongation in the time of larval exposure to the treated medium caused, on the other hand a remarkable increase in the rate of larval mortality during the first 48 hours of treatment. During the third day after treatment (48 - 72 hrs.); the rates of new mortalities were (with all concentrations of bacteria and with both instars) either nil or insignificant (Table, 17).

The log concentration probit lines for the two instars, after 3 days of treatment, are plotted in Fig. (8). Data in this figure, clearly, show that

Table (17) : Corrected percentages of mortality among the pink bollworm larvae when the second and fourth instar larvae were fed on synthetic diet contaminated with different concentrations of B. thuringiensis spores. (20 larvae were tested/treatment).

Concentration (I.U./7 gm.diet)	Corrected % mortality after different periods of treatment					
	Second instar larvae			Fourth instar larvae		
	24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
80	15.79	29.41	29.41	15.79	16.67	22.22
160	31.57	47.06	52.94	15.79	22.22	27.78
240	36.84	64.71	64.71	31.58	33.33	33.33
320	42.11	58.82	64.71	31.58	33.33	44.44
400	57.89	82.35	82.35	42.11	50.00	55.56

N.B. Percentages mortality in control were; 5, 10.5 and 10.5 % for the second instar and 5, 5.26 and 5.26 % for the fourth instar, after 24, 48 and 72 hours, respectively.

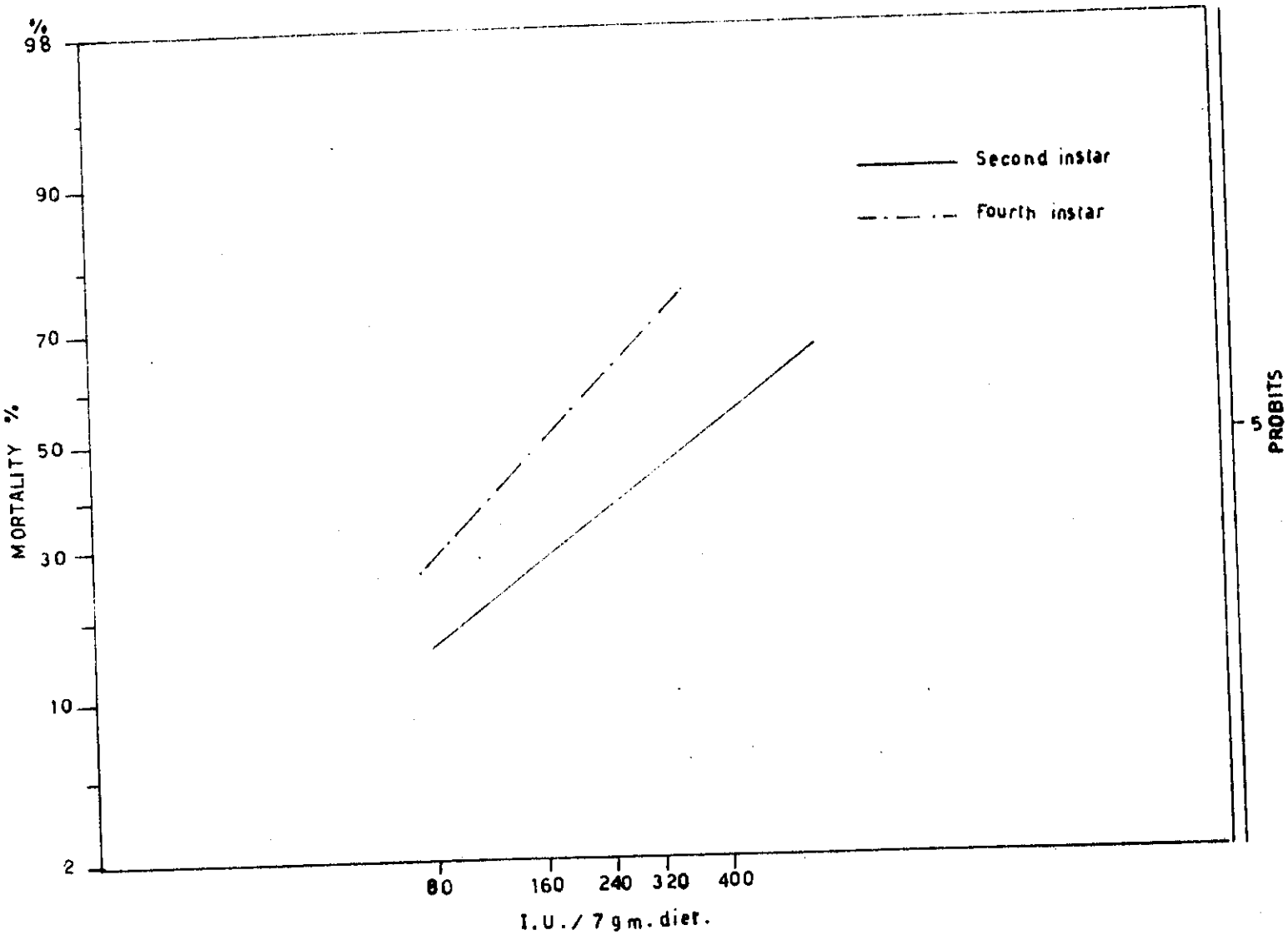

Fig.(8) -Log.con.probit lines showing the effect of feeding of the 2nd and 4th instar larvae of P.gossypiella, for 72 hours, on diet contaminated with B.thuringiensis spores in Bactospeine on larval mortality.

the effect of B. thuringiensis on larval mortality was a concentration dependent, from one hand, and that the 2nd instar larvae were generally more susceptible, for bio-insecticidal treatment, than those of the fourth instar, on the other hand, The LC_{50} for the second instar treatment was 154.69 I.U./7 gm. of the artificial diet (Fig. 8) with confidence limits of 52.69-184.67 I.U./7 gm. diet (Table, 18). For the fourth instar treatment; the LC_{50} was 429.83 (226.36 - 816.21) I.U./7 gm. diet (Table, 19), thus, also, indicating higher tolerance for bio-insecticidal treatment for the latter instar than the former one.

Calculations of the LT_{50} (Table, 20) showed that this value ranged from 0.68 to 9.6 days in case of treatment of the second larval instar and from 1.95 - 22.09 days in case of the fourth instar treatment. As shown in Table (20); the LT_{50} shortened as the applied dose of B. thuringiensis spores increased and as the larval age decreased.

The percentage of failure in pupation among the surviving larvae, from different treatments and control, are recorded in Table (21). These percentages were generally low ranging from 0 to 16.67 % when

Table (18) : Percentages mortality among the pink bollworm larvae, fed in their 2nd instar on nutrient diet contaminated with different concentrations of B. thuringiensis spores in Bactospeine.

Concentration (I.U./7gm. diet)	Corrected mortality % (observed)	Expected mortality % (from graph)	Obs.- Exp.	Contribution to Chi^2
80	29.41	29	0.41	0.00008
160	52.94	51	1.94	0.00151
240	64.71	64	0.71	0.00022
320	64.71	73	- 8.29	0.03487
400	82.35	78	4.35	0.01103
Total Chi^2				0.04771

Experimental Chi^2 = 0.9542

Tabulated Chi^2 = 7.815

* Data are not significantly heterogenous.

The slope = 1.9049

LC_{50} = 154.69 I.U./7 gm. diet.

Confidence limits of LC_{50}:

Upper = 184.67 I.U./7 gm. diet.

Lower = 52.69 I.U./7 gm. diet.

Table (19) : Percentages of mortality among P.gossypiella larvae fed, in their fourth instar, on medium contaminated with B. thuringiensis spores for three successive days.

Concentration (I.U./7 gm.diet)	Observed mortality % (corrected)	Expected mortality % (from graph)	Obs - Exp.	Contribution to Chi^2
80	22.22	16	6.22	0.0288
160	27.78	29	- 1.22	0.0007
240	33.33	38	- 4.67	0.0093
320	44.44	45	- 0.56	0.0001
400	55.56	50	5.56	0.0513
Total				0.0902

Experimental Chi^2 = 1.8040

Tabulated Chi^2 = 7.815

∴ Data are not significantly heterogeneous.

The slope = 1.4609

LC_{50} = 429.83 I.U./7 gm. diet

Confidence limits of LC_{50} : Upper = 816.21 I.U./7 gm.diet.

Lower = 226.36 I.U./7 gm.diet.

Table (20) : Calculated LT_{50} (/days) for 2nd and 4th instar larvae of P. gossypiella fed on nutrient diet contaminated with different concentrations of B. thuringiensis spores in Bactospeine.

Concentration	LT_{50} values	
(I.U./7 gm.diet)	Second instar	Fourth instar
80	9.6	22.09
160	2.49	13.20
240	1.46	11.74
320	1.50	7.79
400	0.68	1.95

N.B. Twenty pink bollworm larvae, of each instar, were tested per treatment.

Table (21) : Percentages of failure in pupation and of adults emergence for P. gossypiella fed, in the 2nd and 4th instars, on synthetic diet treated on the surface with different concentrations of B. thuringiensis spores in Bactospeine.

Concentration (I.U./7 gm.diet)	Second instar			Fourth instar		
	No. of larvae immediately before pupation	% failure in pupation among surviving larvae	% of emergence among normal pupae	No. of larvae immediately before pupation	% failure pupation among surviving larvae	% of emergence among normal pupae
80	12	16.67	100	14	0.0	100
160	8	12.50	85.71	13	7.7	91.67
240	6	16.67	80.00	11	0.0	85.70
320	6	0.00	66.67	9	33.33	80.00
400	3	0.00	0.00	7	14.29	80.00
Control	17	0.00	88.24	18	0.0	100

larvae of P. gossypiella were exposed, in their second instar, to treated died, and from 0 to 33.33 % for the 4th instar treatment. A slight effect on adults emergence from the normally formed pupae could be also detected in the two groups of treated larvae (Table, 21). The low concentration (80 I.U./ 7 gm. diet) did not affect adults emergence, where all the resultant normal pupae emerged into adults. Higher concentrations (160-400 I.U./7 gm. diet), on the other hand, affected the percentages of emergence. These percentages, generally, decreased as the applied concentration increased, ranging from 0 - 85.71 % and 80 - 91.67 % when larvae were exposed to treated diet at their 2nd and 4th instar, respectively (Table, 21). The percentages of adults emergence were, generally, higher for the fourth instar treatment than the second one.

IV.3.3. Effect on resting larvae of P. gossypiella :

The effect of intrahemocoele injection with different doses (8, 16, 24, 32 and 40 I.U./larva) of B. thuringiensis spores, in Bactospeine suspension, on the rates of mortality among the pink bollworm diapausing larvae is shown in Table (22). The recorded data

Table (22) : Accumulative mortality percentages (corrected) among resting larvae of P. gossypiella (*) injected with five doses of B. thuringiensis.

Days after treatment	Dose (I.U. / larva)				
	8	16	24	32	40
1	21.27	36.17	27.66	40.43	40.43
2	37.78	62.22	68.89	80.00	82.22
3	40.00	66.66	71.11	80.00	88.89
4	42.22	68.89	71.11	80.00	93.33
5	42.22	68.89	73.33	82.22	93.33
6	42.22	68.18	71.11	81.82	95.45
7	43.18	70.45	72.73	86.36	95.45

* Data were obtained from 50 diapaused larvae/treatment.

N.B. Accumulative mortality percentages in control were 6, 10, 10, 10, 12, 12, 12 within 7 days after treatment, respectively.

indicate that B. thuringiensis, significantly, increased the larval mortality rate. The maxima rates of mortality occurred after 24 and 48 hours of treatment, where the corrected percentages of mortality ranged between 21.27 to 40.43 % after 24 hrs. and 37.78 to 82.22 % after 48 hrs., depending on the applied dose. During the period that extended from the third to the seventh day after treatment; few number of larvae died due to B. thuringiensis infection, where the final percentages of mortality ranged from 43.18 to 95.45 % (Table, 22). The dosage-mortality line of B. thuringiensis on the diapaused larvae of P.gossypiella after 72 hours of treatment, is graphically plotted in Fig. (9) showing the LD_{50} (11.29 I.U./larva). The confidence limits of LD_{50} (at 95 % probability) were 8.59 - 14.82 I.U./larva (Table, 23).

Data in Table (23) and Fig. (9) show that the larval mortality rate, due to injection with B. thuringiensis spores, was directly affected with the applied dose, i.e.; an augmentation in the larval mortality percent occurred as the injected bacterium spores/larva increased.

The calculated values of LT_{50} were 10.82, 1.53, 1.50, 1.10 and 1.10 days when the injected numbers

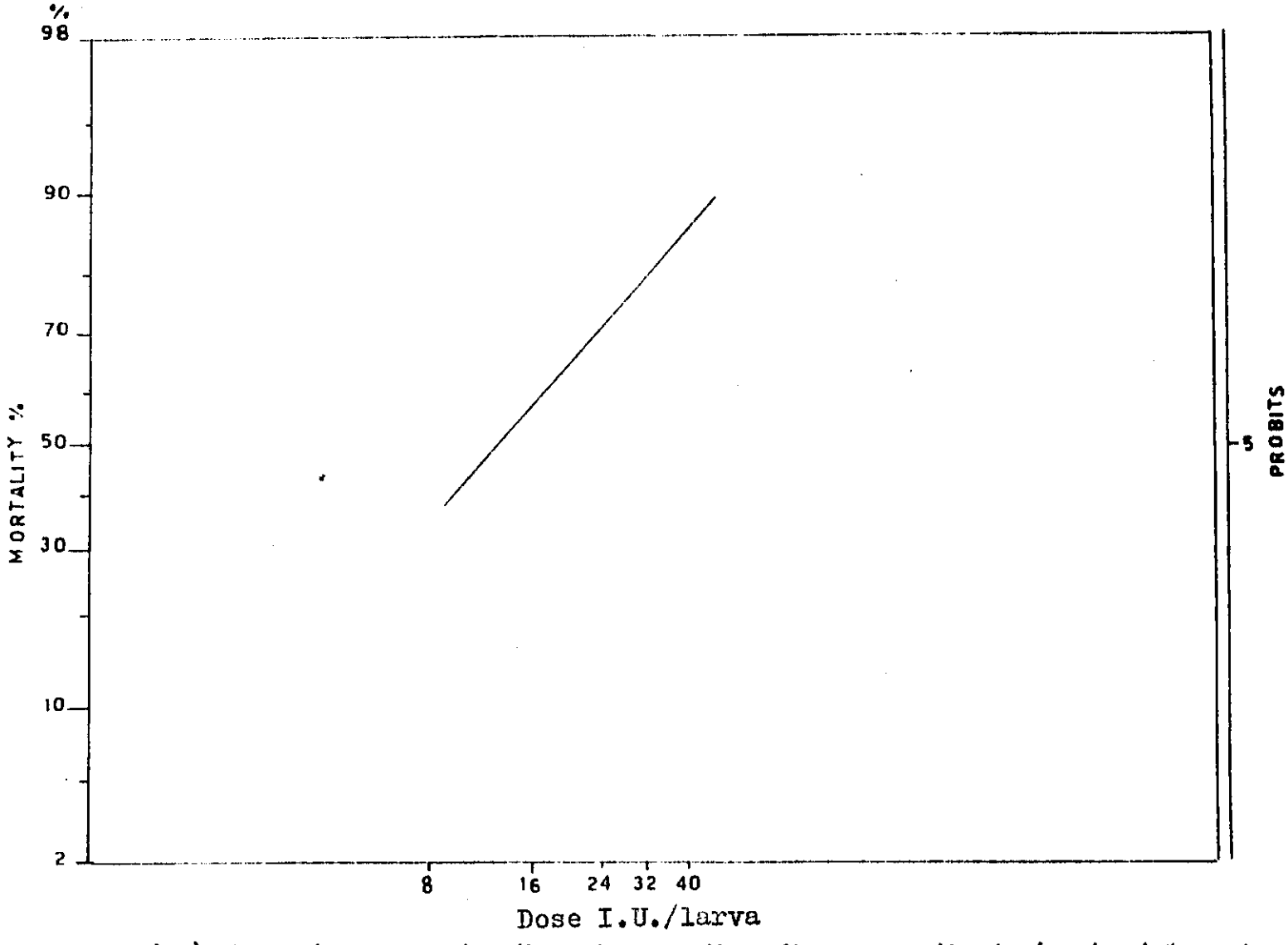

Fig.(9) _ Log. dosage probit line showing the effect of B. thuringiensis, injected in resting larvae of P. gossypiella, on larval mortality after 3 days of treatment.

Table (23') : Percentages of larval mortality among diapaused larvae of P. gossypiella after 3 days of injection with different doses of B. thuringiensis.

Dose (I.U./larva)	Observed mortality % (corrected)	Expected mortality % (from graph)	Obs.-Exp.	Contribution to Chi^2
8	40.00	40	0.00	0.0000
16	66.66	63	3.66	0.0057
28	71.11	75	- 3.89	0.0081
32	80.00	82	- 2.00	0.0027
40	88.89	87	1.89	0.0032
Total				0.0197

Experimental Chi^2 = 0.985

Tabulated Chi^2 = 7.815

* Data are not significantly heterogenous.

The slope = 1.9583

LD_{50} = 11.286 I.U./larva.

Confidence limits of LD_{50} :

Upper = 14.82 I.U./larva.

Lower = 8.59 I.U./larva.

of spores were 8, 16, 24, 32 and 40 I.U./larva, respectively. These data indicate , on the other hand, a negative relationship between the time required to kill 50 % of the treated larvae and the number of injected spores/larva.

IV.4. Effect of field application of B. thuringiensis on P. gossypiella infesting cotton bolls :

The aim of this experiment was to determine the effect of field application of water suspension of a bio-insecticide of B. thuringiensis (Bactospeine) on the larval population of P. gossypiella in cotton bolls, resultant pupae and adults emergence and, also, on the reproductivity of the emerged adults.

IV.4.1. Effect on larvae and subsequent stage :

Data recorded in Tables (24 & 25) show the numbers of pink bollworm larvae counted in cotton bolls after spraying, on cotton plants sown at two planting dates (March, 7th and 28th), with two different concentrations (2.5 and 4 Kg./200 litres of water/feddan) of Bactospeine suspension (40 x 10^9 and 64 x 10^9 I.U./ feddan, respectively) and in those collected from un-sprayed plants. The counted numbers of larvae, in both treatments, were significantly lower than those in the control. As shown in Table (26); the percentages of reduction in larval population were 47.11 and 35.16 % for the first planting date and 31.15 and 33.84 % for the second planting date, after spraying with 40 x 10^9

Table (24) : Effect of spraying with Bactospeine suspension (at two application rates) on the pink bollworm larvae and the resultant pupae in cotton fields sown on March, 7th 1981. (Date of bioinsecticide application was August, 10th 1981.

Date of inspection	Treatment (I.U./feddan	No. of larvae/ 60 bolls	Dead larvae		Normal pupae		Malformed pupae	
			No.	%	No.	%	No.	%
17.8.81	40×10^9	3.0	1.0	33.33	2.0	100.00	0	0
	64×10^9	8.0	5.0	62.50	3.0	100.00	0	0
	Control	11.0	6.0	54.55	4.0	80.00	1	20.00
24.8	40×10^9	19.0	13.0	68.42	5.0	83.33	1	16.67
	64×10^9	10.0	3.0	30.00	7.0	100.00	0	0
	Control	13.0	2.0	15.38	11.0	100.00	0	0
31.8	40×10^9	18.0	9.0	50.00	9.0	100.00	0	0
	64×10^9	36.0	21.0	58.33	14.0	93.33	1	6.67
	Control	41.0	12.0	29.27	29.0	100.00	0	0
7.9	40×10^9	28.0	17.0	60.71	11.0	100.00	0	0
	64×10^9	34.0	13.0	38.23	20.0	95.24	1	4.76
	Control	55.0	19.0	34.55	33.0	91.67	3	8.33
14.9	40×10^9	32.0	10.0	31.25	21.0	95.45	1	4.55
	64×10^9	40.0	15.0	37.50	23.0	92.00	2	8.00
	Control	67.0	8.0	11.94	59.0	100.00	0	0
21.9	40×10^9	28.0	10.0	35.71	18.0	100.00	0	0
	64×10^9	22.0	10.0	45.45	12.0	100.00	0	0
	Control	57.0	6.0	10.53	51.0	100.00	0	0
28.9	40×10^9	27.0	7.0	25.93	18.0	90.00	2	10.00
	64×10^9	40.0	5.0	12.50	34.0	97.14	1	2.86
	Control	49.0	3.0	6.12	44.0	95.65	2	4.35
Overall	40×10^9	155.0*	67.0	43.23	84.0	92.31	7	7.69
	64×10^9	190.0*	72.0	37.89	113.0	95.76	5	4.24
	Control	293.0	56.0	19.11	231.0	97.47	6	2.53

* Numbers of larvae, significantly, lower than control.

Table (25) : Effect of spraying with Bactospeine suspension (at two rates) on larvae (and subsequent pupae) of P. gossypiella in cotton field sown on March, 28th 1981. (Date of bioinsecticide spraying was August, 8th 1981.

Date of inspection	Treatment (I.U./feddan	No. of larvae/60 bolls	Dead larvae		Normal pupae		Malformed pupae	
			No.	%	No.	%	No.	%
17.8.81	40×10^9	9	6	66.67	2	66.67	1	33.33
	64×10^9	6	3	50.00	1	33.33	2	66.67
	Control	8	4	50.00	3	75.00	1	25.00
24.8	40×10^9	16	5	31.25	10	90.90	1	9.09
	64×10^9	13	5	38.46	6	75.00	2	25.00
	Control	14	5	33.33	8	88.88	1	11.11
31.8	40×10^9	42	23	54.76	15	78.95	4	21.05
	64×10^9	22	5	22.72	14	82.35	3	17.65
	Control	30	6	20.00	24	100.00	0	0
7.9	40×10^9	14	4	28.57	9	71.43	1	28.57
	64×10^9	15	5	33.33	9	66.67	1	33.33
	Control	49	7	14.29	37	88.10	5	11.90
14.9	40×10^9	48	9	18.75	31	79.49	8	20.51
	64×10^9	60	9	15.00	45	88.24	6	11.76
	Control	68	7	10.29	59	96.72	2	3.28
21.9	40×10^9	36	3	8.33	31	93.94	2	6.06
	64×10^9	41	7	17.07	33	97.06	1	2.94
	Control	50	2	4.00	47	97.92	1	2.08
28.9	40×10^9	14	4	28.57	10	100.00	0	0
	64×10^9	15	2	13.33	13	100.00	0	0
	Control	41	5	12.20	35	97.22	1	2.78
Overall	40×10^9	179*	54	30.17	108	86.40	17	13.60
	64×10^9	172*	36	20.93	121	88.97	15	11.03
	Control	260	36	13.25	213	95.09	11	4.91

* Numbers of larvae, significantly, lower than control.

Table (26) : The percentages of reduction in number of the pink bollworm larvae in bolls of cotton sown at two planting dates, after spraying with two rates of Bactospeine.

Date of sampling	Cotton sown in March, 7th sprayed with		Cotton sown in March, 28th sprayed with	
	2.5 Kg./ feddan	4 Kg./ feddan	2.5 Kg./ feddan	4 Kg./ feddan
17.8.81	72.73	27.27	0.00	25.00
24.8	0.00	23.08	0.00	7.14
31.8	56.10	12.20	0.00	26.67
7.9	49.10	38.18	71.43	69.39
14.9	52.24	40.30	29.41	11.76
21.9	50.88	52.24	28.00	18.00
28.9	45.52	18.34	65.86	63.41
Average	47.11	35.16	31.15	33.84

and 64 x 10^9 I.U./feddan, respectively. No significant difference was, on the other hand, detected neither between the counted larvae from control in the two planting dates, nor between those counted after application of the two rates of Bactospeine suspension.

Larvae that collected from cotton bolls were fed, in the laboratory, until pupation and subsequently adults emergence. Percentages mortality among larvae from treated areas (43.23 and 37.89 % for the first planting date and 30.17 and 20.93 % for the second planting date, after spraying with 2 and 4 Kg. Bactospeine/feddan, respectively) were, significantly, higher than those died among larvae of the untreated area; 19.11 and 13.25 % for the two planting dates, respectively (Tables, 24 & 25). Percentages mortality were, on the other hand, generally higher among larvae collected from bolls of the first planting date than those of the second planting date.

As shown in Tables(24 & 25); the percentages of malformed pupae (pupae with retention of larval structures), in case of cotton sown in March, 7th were 7.69, 4.24 and 2.53 % for application of 2.5 and 4 Kg. Bactospeine/feddan and control, respectively. In case

of March, 28th cotton sowing; these percentages were 13.6, 11.09 and 4.91 %, respectively. The malformed pupae, usually died in the pupal stage, i.e.; did not develop into adults. Thus indicating higher mortality rates among the pupae that developed from larvae collected from both treatments than those from the control. A general tendency of higher percentages of malformed pupae from larvae of the second planting date than those developed from larvae of the first planting date could, also, be noticed (Tables, 24 & 25).

The percentages of normal pupae that developed from collected larvae were, consequently, lower among larvae that obtained from treated areas than those from the control (Tables, 24 & 25). These normal pupae, usually developed into normal adults.

IV.4.2. Effect on adults reproductivity :

Moths of P. gossypiella that resulted from larvae of treated and untreated areas were allowed, in the laboratory, to deposit their eggs until females mortality. The oviposited eggs were, subsequently,

left until hatching. As shown in Table (27), the averages in total number of eggs/female obtained from the first planting date (March, 7th) areas treated with 2.5 and 4 Kg. Bactospeine/feddan and control were 22.68 ± 29.6, 15.25 ± 20.4 and 54.3 ± 34.1 eggs, respectively. The respective averages in the total number of eggs/female from the second planting date areas were 23.1 ± 58.6, 27.3 ± 23.3 and 44.4 ± 28.1 eggs. The percentages hatching among eggs of moths obtained from the first planting date were 81.13, 68.20 and 92.08 %, respectively, while those in case of eggs collected from females of the second planting date were 70.13, 74.36 and 75.68 %, respectively (Table, 27).

The mentioned results indicate that, as well as the bio-insecticidal application on cotton plants caused a considerable reduction in the population of P. gossypiella larvae infesting cotton bolls and that of the resultant adults, treatments with either of the two concentrations of Bactospeine, considerably, reduced the numbers of eggs that have been laid by the resultant females and, also, the percentages hatching among the deposited eggs.

Table (27) : Effect of spraying with Bactospeine suspensions, on cotton plants sown at two planting dates, on the reproductivity of the resultant P. gossypiella adults.

Date of sowing	Rate of application (Kg./fed.)	Average number of deposited eggs/female	Average number of hatched eggs/female	% Hatching
March, 7th	2.5	22.68±29.6* (18-146)	18.4±28.5 (8-130)	81.13
	4.0	15.25±20.4 (8-96)	10.4±16.2 (4-81)	68.20
	Check	54.30±34.1 (117-280)	50.0±34.4 (99-223)	92.08
March, 28th	2.5	23.10±58.6* (0-244)	16.2±38.3 (0-150)	70.13*
	4.0	27.30±23.3 (54-167)	20.3±16.7 (33-111)	74.36
	Check	44.40±28.1 (120-255)	33.6±15.9 (90-164)	75.68

N.B. Date of bio-insecticidal application was August, 10th on all treatments.

* = Values, significantly, lower than control.

Statistical analysis of the obtained data indicated that the reduction in the average of total number of eggs laid by a single female from treated areas (in both Bactospeine treatments) of the first planting date, than that of a female from untreated area was significant. In case of females from areas sown in March, 28th; Bactospeine treatments, with either of both concentrations, caused insignificant reduction in the average number of eggs/female.

The reduction in percentages of hatched eggs, due to application of both Bactospeine suspensions on cotton plants, was statistically insignificant in case of females from larvae of areas sown in March, 7th. Eggs deposited by females from areas of the second planting date treated with 2.5 Kg. Bactospeine/feddan showed a significant reduction in their percentage hatching than control, while the decrease in percentage hatching due to spraying with 4 Kg. Bactospeine/feddan was statistically insignificant.