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EFFECT OF *BACILLUS THURINGIENSIS* BERLINER, A CHEMICAL INSECTICDE AND ITS MIXTURES AGAINST THE UNPARASITIZED AND PARASITIZED *SPODOPTERA LITTORALIS* (BOISD.) LARVAE

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Abstract

The second instar larvae of the cotton leafworm *spodoptera littoralis* (4 days old) were fed after four days of being parasitized individually by *Microplitis rufiventris* Kok. (=8 days old) on castor bean leaves dipped in different concentrations of *Bacillus thuringiensis* (delfin), the pyrethroid (baythroid) and their combinations. Data indicate that the parasitized larvae showed lower mortality rates that those of unparasitized ones. Consequently, the LC_{50} values were larger in case of parasitized larvae than those required for unparasitized ones at the same age. The combination of delfin and LC_{10} level of baythroid showed mortality ranged between their individual values.

Data also show latent or delayed toxicity of the tested insecticides on the parasitoid progeny. Bioinsecticide latent effect is very low as regards cocoon formation and even adult emergence. The immature larvae of the parasitoid complete their development in *B. thuringiensis* infected host, if the host does not die before the maturity of the larval parasitoid inside it completed. While the latent toxicity of chemical insecticide is more than that of the bioinsecticide, but the combination of the two insecticides ranges in between.

INTRODUCTION

The cotton leafworm, *Spodoptera littoralis* is one of the main pests in Egypt with polyphagous habit feeding on many crops. This insect is found almost all the year round, causing great damage to the different parts of plants (Kares, 1990). *Microplitis rufiventris* Kok., a solitary internal larval parasitoid, is one of the important cotton leafwom, *S.littoralis* parasitoids. Also, it parasitizes the lesser cotton leafworm, *S.exigua* Hbn. and the american bollworm, *Heliothis armigera* Hbn.

The effect of *B.thuringiensis* against the lepidopterous pest and the related parasitoids was studied by Thoms and Watson (1986); McDonald *et al.* (1990) and Kares (1991a).

Several authors studied the joint use of parasitoids for contolling many pests (Shalaby *et al.*, 1986; Kares, 1990; Idris and Grafius, 1993a&b). The additive effects of *B.thuringiensis* with different chemical insecticides were tested on *S.littoralis* by many authors (Kares, 1991b).

The current field application of chemical insecticides is considered as one of the main factors affecting the agroecosystem. From this point of view, minimizing of the application of pesticides within a program of integrated pest management appears necessary. In this respect, the microbial control may be assayed, either alone or in combination with chemical insecticides.

The present investigation was carried out to study the effects of *B.thuringiensis* (delfin), a chemical insecticide (baythroid) and their combinations against the unparasitized *Spodoptera littoralis* (boisd.) larvae and those parasitized by *Microplitis rufiventris* Kok.

MATERIALS AND METHODS

1. Rearing of the cotton leafworm, *Spodoptera littoralis* (Bioisd.): The rearing technique described by Ibrahim (1974) was followed in this investigation.

2. Rearing of *Microplitis rufiventris* Kok.: The same technique described by Kares *et al.* (1998) was followed in this investigation

3. Materials used

3.1. Bioinsecticide (Delfin): Delfin, a selective bacterial insecticide containing $53X10^6$ S.U. of *B. thuringiensis* var. *kurstaki/*g of product.

3.2. Chemical insecticide (Baythroid): Baythroid 5% E.C. Formulation: Emulsifiable concentrate containing 50 g a.i/liter. (Cyfluthrin) Cyano-(4-fluoro-3-phenoxybenzyl)-methyl-3-(2,2-dichloroethyl)-2,2-dimethyl-cyclo-propane carboxylate used at a rate of 3.7g a.i./feddan.

4. Treatments: For host larvae parasitized by *M.rufiventris*, the individual parasitism (to insure parasitism) was operated on *S.littoralis* larvae of second instar in glass vials (10X3.5 cm). The vial was covered with a plastic cover, with a pore in the middle for allowing a brush to enter. The vial contained five parasitoid females (replaced by others from the rearing stock after the parasitization of 50 larvae individually occurred) was directed to a fluorescent lamp and the host larvae mounted, individually, on a fine hair brush introdcued inside the glass vial till reaching the adult famales. The feces of the host contaminated in the brush's hair facilitated the attraction between the female parasitoids and the host to complete parsitization.

4.1. Concentrations tested: Weights of 0.3774, 0.7547, 1.1320, 1.5094, 1.8868 and 2.2642 g of wettable powder of delfin (containing 53 million *Spodoptera* Units of *B.thuringiensis* var. *kurstaki*/g powder) were diluted with constant volume of 50 ml water was prepared to obtain the final concentrations of $4X10^4$,$8X10^4$, $12X10^4$, $16X10^4$, $20X10^4$and $24X10^4$ S.U., respectively.

A volume of 1 ml baythroid 5% E.C. ($5X10^4$ ppm) was dissolved in 100 ml water to obtain the concentration of 500 ppm as a stock solution. A volume of 100 ml water to obtain the final concentrations of 20, 30, 40, 50, 60 and 70 ppm, respectively.

Different concentrations of delfin were prepared and mixed with of LC_{10} baythroid for unparasitized larvae or with LC_{10} for parasitized larvae to obtain the final concentrations of ($4X10^4$, $8X10^4$, $12 X10^4$, $16X10^4$, $20X10^4$, and $24X10^4$ S.U.)+ LC_{10} ppm.

4.2. Procedures: The following procedures were followed in all experiments:

The parasitized second instar larvae (4 days old) were treated after 4 days of individual parasitism. Also, the unparasitized *S.littoralis* larvae were treated at the same age (8 days old) and were fed on castor-bean leaves dipped in the different concentrations of the bio and chemical insecticides.

Three replicates of 10 larvae each into a cup (6X7.5 cm), were allowed to feed on the treated castor-bean leaves for a period of 48 hours in the case of bioinsecticide and combination treatments and for a period of 24 hours in the case of chemical insecticide treatments. The mortality rates were recorded daily. Larvae that survived after treatment were transferred to other cups with untreated castor-bean leaves on which they fed till the emergence of the full grown larvae of parasitoid. About one hour later the larvae of parasitoid pupated inside their cocoons and were kept till adult emergence.

Before introducting the larvae to treated food, they were starved for sixth hours in order to obtain rapid simultaneous of the offered food.

The control tests were conducted using the source of food, mixed with water only. The experiments were carried out under laboratory conditions of 28±1°C and

65±4% R.H.

5. Statistical analysis: As mortality percentages in control larvae and adult parasitoids ranged from 5-20%,obtained data were corrected according to Abbott's formula (1925).

Data of LC_{50} values at 5% confidence limits and slopes of regression lines were represented and interpreted using probit analysis statistical method of Lichefield and Willcoxon (1949).

The combined action of each mixture was expressed as the Co-toxicity factor (C.F.)estimated according to Sun and Johnson's equation (1960), they introduced a simple method for calculation of joint toxicity of various insecticide mixtures. To evaluate the effect of different combinations of insecticides used, the following equation was formulated:

$$\text{Co-toxicity factor} = \frac{\text{Observed \% mortality} - \text{Expected\%mortality}}{\text{Expected\%mortality}} \times 100$$

RESULTS AND DISCUSSION

1. On *S.littoralis* larvae healthy and parasitized by *M.rufiventris* (for larval parasitic stage inside the host)

a. Bioinsecticide treatments: The corrected mortality percentages after 72 hours (at which LC_{50} were estimated)for the parasitized *S.littoralis* larvae treated with delfin increased by increasing delfin's concentrations and ranged from 40.00 to 73.33 at concentration of 4 to $24X10^4$ S.U. These percentages in case of unparasitized larvae at the same age and concentrations ranged from 6.66 to 80.00, respectively, Table 1. However, the LC_{50} value was $15.2X10^4$ S.U. for parasitized larvae, while this value in case of unparasitized larvae was $12.2X10^4$ S.U., Table 1. These results indicate that parasitized larvae are less susceptible to bioinsecticide treatments than the unparasitized ones at the same age. These results agree with those of Kares (1991 a) on the second larval instar of Phthorimaea operculella parasitized by Apanteles litae var. operculellae and fed on potato leaves contaminated with dipel for 48 hours. Also, McDonald *et al.* (1990) found that after day 2 of parasitization, LC_{50} of 4 th instar *Pieris rapae* larvae parasitized with the braconid *Cotesia rubecula* and treated with *B.thuringiensis* subsp. *kurstaki*-endotoxin was 30 times higher than those of unparasitized larvae and by day 4 it was 180 times greater. However, Idris and Grafius (1993 b) indicated that the diamondback moth, *Plutella xylostella* larvae parasitized by *Diadegma insulare* were significantly less sensitive to ingested *B.thuringiensis* than were non parasitized larvae 48 hours treatment.

b. Chemical insecticide treatments: The percent mortality of parasitized larvae after 24 hours of treatment with baythroid concentrations between 20 to 70 ppm, ranged from 16.66 to 70.00. While in case of unparasitzed larvae, the percent ranged between 23.33 to 100%. Percent of larval mortality in the control was 3.33%. The LC_{50} values were 70(56.5-86.80)ppm for parasitized larvae and 46 (38.3-55.2) ppm for unparasitized ones, Table 2. These data reveal that the parasitized larvae are less susceptible to chemical insecticide treatments than the unparasitized ones. These results agree with those of Kares (1978) who studied the effect of parasitism by *Chelonus inanitus* or *M.rufiventris* on the susceptibility of *S.littoralis* larvae to tamaron LC, cyolane EC and tokuthion EC. Shalaby *et al.* (1986) indicated that *S.littoralis* larvae parasitized by *M.rufiventris* were less susceptible to bolstar 720 EC treatments than the unparasitized ones of the same age. Also, the findings of Kares (1990) on *S.littoralis* larvae parasitized by *Zele nigricornis* show that LT_{50} values were higher in case of parasitized larvae after the treatments with diflubenzuron. Moreover, Idris and Grafius (1993 b) noticed that the diamonback moth, *P. xylostella* larvae parasitized by *D.insulare* were significantly less sensitive to insecticides (azinphosmethyl, permethrin, methomyl and chlorothalonil) than were unparasitized larvae.

c. Combination treatments: Two methods were used to determine the combined effect of different delfin concentrations with sublethal concentration LC_{10} of baythroid:

The first method: After 72 hours from treatment with a combination of delfin and calculated LC_{10} of baythroid (=9.2 ppm for unparasitized larvae) the mortalities were 30.00, 50.00, 63.33, 73.33, 80.00 and 90.00% for unparasitized larvae at concentrations of 4, 8, 12, 16, 20, 24X10^4 S.U.+9.2 ppm, but were 26.66, 40.00, 53.33, 66.66, 76.66 and 83.33% for parasitized larvae. Percent larval mortality in the control was 3.33%. The LC_{50} values were 8.00X10^4 S.U. and 10.40X10^4 S.U., for unparasitized and parasitized larvae, respectively, Table 2. Before the emergence of full grown larvae of the parasitoid from the host, a group of unparasitized and parasitized *S.littoralis* died four days after treatment. The corrected mortality percentages at the 4th day of delfin treatment ranged between 33.33 to 93.33% for unparasitized larvae and 14.29 to 78.57% for parasitized ones, while in case of baythroid, it ranged between 60.71 to 100.00% for unparasitized larvae and 25.00 to 92.85% for parasitized larvae, also in case of delfin and baythroid combinations ranged between 42.85 and 96.42% for unparasitized larvae and 25.01 to 85.71% for parasitized larvae.

Generally, the parasitized larvae showed lower mortality rates than the unparasitized ones at different experiments. In addition, LC_{50} values were larger in case of parasitized larvae than those required for unparasitized at the same age.

Kares *et al.* (1998) indicated that the ratio of the total castor-bean leaves eaten by *S.littoralis* larvae parasitized by *M. rufiventris* to that of the healthy ones was 1:3.16. This difference in the amount of food eaten may interpret the difference in the susceptibility between the parasitized and healthy larvae, as the parasitized larvae ceased feeding and therefore ingested less toxicant.

Moreover, chemical insecticides showed higher mortality percentage in the unparasitized and parasitized larvae than in those treated with the bioinsecticides, but for treated with the combination of the bioinsecticide with calculated LC_{10} level of chemical insecticide, the percent mortality was in between the two values.

The second method: Co-toxicity factor of the combination of *B. thuringiensis* (delfin) and the sublethal dose of chemical insecticide (baythroid):

Table 3 shows results of combination of delfin at low concentrations of 4,8 and $12X10^4$ with both LC_{10} level of baythroid of 9.2 ppm for unparasitized larvae and 14 ppm for parasitized ones caused mortalities of 30.00, 50.00, 63.33, 26.66, 40.00 and 53.33, respectively. The co-toxicity. factor values were +57.39, +54.32 and +29.09% for unparasitized larvae and + 56.82, +31.88 and +22.15% for parasitized ones at the same concentrations, respectively. These three concentrations of delfin with the calculated LC_{10} level of baythroid for treated unparasitized and parasitized larvae produced potentiation.

Data indicate that, when delfin + LC_{10} level of baythroid were used for unparasitized larvae, the potential effect was more active being +57.39, +54.32 and +29.09% as compared to the parasitized larvae, being +56.82, +31.88 and +22.15%.

When delfin at high concentrations of $16X10^4$, $20X10^4$ and $24X\ 10^4$ S.U. was combination with + LC_{10} level of baythroid for unparasitized and parasitized larvae, the mortalities were 73.33, 80.00 &90.00 and 66.66, 76.66 &83.33%, respectively. The co-toxicity factor values were + 17.52, + 15.84 and + 9.22 for unparasitized larvae; +16.95, +9.00 and + 3.37 for parasitized individuals, respectively. From these results, it is clear that three concentrations produced additional effects. These results agree with those of Kares (1991 b) who mentioned that the pink bollworm, *Pectinophora gossypiella* when treated with combination of bactospeine at low concentrations ($1.5X10^4$ and $3X10^4$ I.U.) and both LC_{10} for 16 ppm cyanophos and 8 ppm fenvalerate produced potentiational effect, but when bactospeine at high concentrations of $4.5X\ 10^4$, $6X\ 10^4$ and $7.5\ X\ 10^4$ I.U. was combined with LC_{10} level of cyanophos and fenvalerate produced additional effects.

2. On cocoons and adult stages emerging from treated host larvae: The full grown larvae of parasitoid emerged from the host larvae after seven to eight days of parasitism (Kares *et al.*, 1998. The reduction in the percent pupation of full grown parasitoid larvae emerging from *S.littoralis* larvae treated with different concentrations of delfin, baythroid and the combination of both of them resulted in :

1. Failure of the full grown larvae to emerge completely (Partial emergence).

2. Failure of the emerged full grown larvae to spin their cocoons.

3. Failure of the full grown larvae to make complete cocoons, partial formation of cocoons (malformed cocoons).

Also, the percent reduction of emerging *M.rufiventris* adults may be due to the faillure of the adult parasitoid to emerge completely from their cocoons (partial emergence).

The effects of delfin, baythroid and their combination on cocoons and adult of parasitoid are recorded in Table 4.

These data prove that there was latent or delayed toxicity effect of the insecticides on the parasitoid progeny. The term latent toxicity was proposed by Brunson and Wallen (1954). They mentioned that, although the parasitoids were in the form of full grown larvae inside their hosts, at the time of insecticidal application, the complete toxic effect on the parasitoid was not apparent until the adult stage.

Our results may confirm that latent (delayed) effect of the bioinsecticide was very low in cocoon formation and even on adult emergence. This may be due to the fact that delfin is a selective microbial insecticide on lepidoptera. In addition, the immature larvae of the parasitoid complete their development in *B. thuringiensis* infected host does not die prematurely. These results agree with Thoms and Watson (1986) who indicated that premature death fo *Heliothis virescens* (the host) was the probable cause of death of the parasitoid *Hyposter exiguae* developing in host infected with dipel. In addition, our results agree with those of Kares (1991 a) who concluded that dipel may be considered as a bioinsecticide when used for the control of *P. operculella* without any harmful effect on the cocoon formation and adult emergence of its main parasitoid, *A. littae* var. *operculellae.*

The results are also in agreement with those of Shalaby *et al.* (1986) who mentioned the high latent toxicity of bolstar 720 E.C. (organophosphorous compound) on *M.rufiventris* and Kares (1990) who acheived the same results when studying the latent toxicity of diflubenzuron on cocoon formation and adult emergence of *Zele nigricornis.*

Table 1. Corrected mortality ratios for parasitized and unparasitized *S. littoralis* larvae treated with bioinsecticide (delfin), chemical insecticide (baythroid) and the combination of both.

Concent-ration	% Cumulative mortality after days of treatment									
	Parasitized larvae					Unparsitized larvae				
	*1 st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	Surviving larvae reaching the pupal stage
S.U.	Bioinsecticide									
0.00	0.00	0.00	3.33	6.66	100	0.00	0.00	0.00	0.00	
$4X10^4$	0.00	3.33	10.00	14.29	100	3.33	10.00	16.66	33.33	
$8X10^4$	0.00	6.66	23.33	21.43	100	6.66	16.66	30.00	40.00	
$12X10^4$	3.33	13.33	36.66	39.29	100	16.66	26.66	46.66	53.33	
$16X10^4$	10.00	16.66	50.00	50.00	100	20.00	33.33	60.00	66.66	
$20X10^4$	16.66	23.33	63.33	67.86	100	23.33	40.00	66.66	80.00	
$24X10^4$	20.00	33.33	73.33	78.57	100	30.00	43.33	80.00	93.33	
ppm	Chemical insecticide									
0.00	3.33	3.33	3.33	6.66	100	3.33	3.33	3.33	6.66	
20	16.66	23.33	23.33	25.00	100	23.33	40.00	53.33	60.71	
30	30.00	36.66	36.66	39.29	100	43.33	56.66	70.00	78.57	
40	43.33	50.00	53.33	53.57	100	60.00	76.66	86.66	89.29	
50	56.66	63.33	63.33	67.86	100	73.33	86.66	93.33	96.42	
60	63.33	73.33	76.66	78.57	100	83.33	96.66	100	100	
70	7.00	86.66	90.00	92.85	100	100	100	100	100	
S.U.+LC_{10} ppm	Combined effect of both									
0.00	0.00	3.33	3.33	6.66	100	0.00	0.00	3.33	6.66	
$4x10^4$ +9.2	10.00	16.66	26.66	25.01	100	13.33	23.33	30.00	42.85	
$8x10^4$ +9.2	16.66	26.66	40.00	39.29	100	20.00	36.66	50.00	57.15	
$12x10^4$ +9.2	26.66	40.0	53.33	53.57	100	33.33	50.00	63.33	67.86	
$16x10^4$ +9.2	30.00	50.00	66.66	71.43	100	43.33	63.33	73.33	78.57	
$20x10^4$ +9.2	36.66	56.66	76.66	78.57	100	53.33	70.00	80.00	85.71	
$24x10^4$ +9.2	40.00	63.33	83.33	85.71	100	60.00	80.00	90.00	96.42	

* = 9 days old of the host larvae = 5 days after parasitism.

Table 2. Comparative toxicities of unparasitized and parasitized *S. littoralis* larvae fed on treated castor-bean leaves with different concentrations of bioinsecticide (delfin), chemical insecticide (baythroid) and the combination of delfin + LC_{10} baythroid.

Treatment	LC_{50}	Slope	Confidence limits at (P 0.05)	
			LC_{50}	Slope
Unparasitized larvae				
Delfin	12.2 X 10^4 S.U.*	3.12	14.95X10^4 :9.96X10^4	4.74: 2.05
Baythroid	46 ppm**	2.24	55.2 : 38.3	3.18 : 1.58
Mixtures	8 X 10^4 S.U. +9.2 * ppm	2.98	10.32 X 10^4 : 6.2X10^4	4.53 : 1.96
Parasitized larvae				
Delfin	15.2 X 10^4 S.U..	2.39	17.78 X 10^4 : 12.99X10^4	3.06 : 1.87
Baythroid	70 ppm	2.93	86.8 : 56.5	4.84 : 1.78
Mixtures	10.4 X10^4 S.U. +9.2 ppm	2.52	12.79 X10^4 : 8.46 X10^4	3.43 : 1.85

* Computed from 72 hours of mortality data .
** Computed from 24 hours of mortality data .

Table 3.The susceptibility of unparasitized and parasitized *S. littoralis* larvae against a mixture of commercial *B. thuringiensis* (delfin) and LC_{10} chemicel insecticide (baythroid).

Larvae	Concentrations		Calculated% motality from LC-p lines		Expected % mortaility	Observed %mortality	Co-toxicity factor	Combined effects
	Bio (S.U)	Chemical LC_{10} (ppm)	Bio	Chemical				
Unparasitized larvae								
	$4X10^4$	9.2	16.66	2.4	19.60	30.00	+56.39	Potentiation
	$8X10^4$	9.2	30.00	2.4	32.40	50.00	+54.32	Potentiation
	$12X10^4$	9.2	46.66	2.4	49.06	63.33	+29.09	Potentiation
	$16X10^4$	9.2	60.00	2.4	62.40	73.33	+17.52	Addition
	$20X10^4$	9.2	66.66	2.4	67.06	80.00	+15.84	Addition
	$24X10^4$	9.2	80.00	2.4	82.40	90.00	+9.22	Addition
Parasitized								
	$4X10^4$	14	10.00	7	17.00	26.66	+56.82	Potentiation
	$8X10^4$	14	23.33	7	30.33	40.00	+31.88	Potentiation
	$12X10^4$	14	36.66	7	43.66	53.33	+22.15	Potentiation
	$16X10^4$	14	50.00	7	57.00	66.66	+16.95	Addition
	$20X10^4$	14	63.33	7	70.33	76.66	+9.00	Addition
	$24X10^4$	14	73.33	7	80.33	83.33	+3.73	Addition

Table 4. The percent reduction in cocoons and adults of *M. rufiventris* after the treatment of parasitized larvae of *S. littoralis*.

		Parasitized larvae before the parasitic larvae began to leave the host		Cocoons of *M. rufiventris*		Adnlts of *M. rufiventris*		The total effect of Bio-insecticide	
Conentrations (S.U.)	% of tested larvae	Mortality number of larvae (1)	% of mortality corrected (2)	No. of parasitic larvae failed to make normal cocoons (3)	% reduction corrected (4)	No. of cocoons failed to emerge (5)	% reduction	Total No. of (1+3+5)	% Corrected
				Bio-insecticide					
0.00	30	2	6.66	1/28	3.57	0/27	0.00	3	10.00
$4X10^4$	30	6	14.29	1/24	0.00	1/24	4.17	7	12.22
$8X10^4$	30	8	21.43	1/22	4.55	0/21	0.00	9	22.22
$12X10^4$	30	13	39.39	0/17	5.88	0/16	0.00	14	40.73
16X104	30	16	50.00	0/14	0.00	1/14	7.69	17	51.84
$20X10^4$	30	21	67.86	0/9	0.00	0/9	0.00	21	66.67
$24X10^4$	30	24	78.57	1/6	16.67	1/5	20.00	26	85.18
				Chemical insecticide					
0.00	30	2	6.66	1/28	3.57	0/27	0.00	3	10.00
20	30	9	25.00	3/21	14.29	5/18	27.78	17	51.84
30	30	13	39.29	5/17	29.41	4/12	33.33	22	70.37
40	30	17	53.57	5/13	38.46	3/8	37.50	25	81.48
50	30	21	67.86	4/9	44.44	2/5	50.00	27	88.89
60	30	24	78.57	3/6	50.00	2/3	66.67	29	96.29
70	30	28	92.85	2/2	100.00	-	-	30	100.00
				Combined effect of both					
0.00	30	2	6.66	1/28	3.45	0/27	0.00	3	10.00
$4X10^4+9.2$	30	9	25.01	0/21	0.00	0/21	0.00	9	22.22
$8X10^4+9.2$	30	13	39.29	0/17	0.00	1/17	5.88	14	40.73
12X104+9.2	30	17	53.37	1/13	7.69	0/12	0.00	18	55.56
$16X10^4+9.2$	30	22	71.43	1/18	12.50	0/7	0.00	23	74.07
$20X10^4+9.2$	30	24	78.57	1/6	16.67	1/5	20.00	26	85.52
$24X10^4+9.2$	30	26	85.71	1/4	25.00	1/3	33.33	28	92.26

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تأثير البكتيريا باسيلس ثورينجينسيس وأحد المبيدات الكيمائية على دوده ورق القطن سبودبترا ليتوراليس غير المتطفل عليها وتلك المتطفل عليها

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عولجت يرقات ورق القطن بعد ٤ أيام من تطفلها الفردى (عمر ٨ أيام) بورق الخروع المعالج بتركيزات الدلفين المختلفة والمنحصرة بين ٤ - ٢٤ X ١٠ ^٤ وحدة من المبيد البكتيري وبتركيزات بين ٢. - ٧٠. جزء من المليون من المبيد الكيميائى البايثرويد وكذلك يخليط من التركيزات المختلفة للدلفين و التركيز القاتل لـ ١٠ ٪ من اليرقات ٩.٢ جزء من المليون من مبيد البايثرويد . وأشارات النتائج إلى قلة معدل موت اليرقات المتطفل عليها بطفيل الميكروبليتس روفيفنترس بالمقارنة بمثيلتها غير المتطفل عليها فى التجارب المختلفة . وبالتالى تكون اليرقات المتطفل عليها أقل حساسية عن غير المتطفل عليها، و كانت قيم التركيز القاتل لـ ٥٠٪ من اليرقات أكبر فى حالة اليرقات المتطفل عليها عنه فى اليرقات غير المتطفل عليها عند نفس العمر . ربما يرجع ذلك إلى قلة كمية غذا اليرقات المتطفل عليها ؛ حيث أنها أقل عنها في حالة غير المتطفل عليها؛ وكما كانت نسبة موت اليرقات المتطفل عليها بالمبيد الكيميائى أكبر من تلك المعالجة بالمبيد البكترى ، بينما كانت نسبة موت اليرقات المعاملة بخليط المبيد البكترى وتركيز المبيد الكيمائى القاتل لـ ١٠٪ من اليرقات بين نسبتى الموت لكل مبيد على حدة .

ولقد أوضحت النتائج أن هناك تأثير سمى متأخر على نسل الطفيل . وكان التأثير المتأخر للمبيد البكتيرى أقل على تكوين الشرنقة وخروج الحشرات الكاملة . وقد يرجع هذا إلى أن يرقات الطفيل تكمل دورة حياتها فى داخل العائل المصاب بالباسيلس ثورينجينسيس وذلك إذ لم يمت العائل قبل نضج الطفيل داخلة ، بينما كان التأثير المتأخر للمبيد الكيمائى أكثر منه للمبيد البكتيرى وتوسطهما تأثير خلط المبيدين .