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EFFECT OF DIET ON THE POTENCY OF CYPERMETHRIN AGAINST THE COTTON LEAFWORM, SPODOPTERA LITTORALIS (BOISD.) (LEPIDOPTERA)

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Abstract

Laboratory studies were carried out to investigate the efficacy of three different diets, namely, cotton leaves, castor bean leaves and an artificial diet and the effect of these diets on the potency of the synthetic pyrethroid, cypermethrin on the certain biological aspects of the cotton leafworm, Spodoptera littoralis.

The results indicated that the effect of the three tested diets on larval mortality, pupation, pupal duration, pupal weight adult emergence and sex ratio was insignificant. But the most observable effect of the diets was on the larval duration and larval growth rate.

The tested diets affected the potency of cypermethrin on larval mortality, larval duration, larval growth rate, and pupal weight, while

the pupal duration, percent pupation percent adult emergence and sex ratio were not significantly affected. The castor bean leaves affected the potency of cypermethrin, followed by the artificial diet, while the cotton leaves gave the best effects when combined with cypermethrin.

Introduction

The cotton leafworm, *S. littroralis* is the major cotton pest in Egypt. Other than cotton, this insect feeds on several important crops causing a considerable damage.

The effect of diet or host plant on lepidopteran insects was studied by many authors, on corn borer (Dittrich and Chiang, 1981), black cutworm (Reese and Field, 1986), *Epiphyas postvittana* (Gu and Danthanarayana, 1992), *Bombyx mori* (Ebeid, 1993; and El-Sayed *et al.*, 1997, 1998), *Palpita unionalis* (Salama *et al.*, 1995), corn earworm and tobacco budworm (Salama and El-Sayed, 1996), *Lobesta botana* (Abou El-Ela *et al.*, 1997), *Lacanobia oleracea* (Bell *et al.*, 2001), *Helicoverpa punctigera* (Nurindah and Tiongson, 2001), *Manduca sexta* (Thompson *et al.*, 2001), *Sesamia nonagrioides* (Reddy *et al.*, 2002) and Mexican rice borer, *Eoreuma loftini* and sugar cane borer, *Diatraea saccharalis* (Steamou *et al.*, 2002).

The effect of diet or host plant on *Spodoptera* spp was studied by some authors, on *S. littoralis* (Mansour, 1981; Alborn, 1996;

Sadek, 1998; El-Gindi, 2000; Zohdy *et al.*, 2000; and Reddy *et al.*, 2002), *Spodoptera frugiperda* (Cespedes *et al.*, 2001), *Spodoptera litura* (Koul *et al.*, 2000) and *Spodoptera exigua* (Inanaga *et al.*, 2001).

Effect of diet on potency of insecticides on lepidopteran insects was studied by some authors, on *M. sexta* (Carlini *et al.*, 1997), *Helicoverpa armigera* (Koul *et al.*, 2000 and Olsen and Daly, 2000), *Pseudoplasia includens* (Ashfaq *et al.*, 2001), *Cydia pomonella* (Knight *et al.*, 2001) and *Plutella xylostella* (Mitchell, 2002).

According to the literature little work has been done on the effect of diet on the potency of insecticides on *S. littoralis*. El-Sayed (1982) studied the effect of host plant on the potency of neem, *Azadirachta indica* against *S. littoralis*. The present work was undertaken to explore the effect of larval diets and the effect of diet on the potency of cypermethrin on certain biological aspects of the cotton leafworm, *S. littoralis*.

Materials and Methods

A laboratory strain of *Spodoptera littoralis* was maintained for several generations at 27 ± 2°C and 65 ± 5% R.H. The larvae were reared on castor bean leaves (*Ricinus communis*), while the adults

were fed on sugar solution. All bioassays were conducted under laboratory conditions mentioned above using early 3rd instar larvae.

Different concentrations (0.01, 0.1, 1.0 and 10.0 ppm) of the tested synthetic pyrethroid (cypermethrin) were prepared in water. Fresh cotton and castor bean leaves were immersed for 30 seconds in the required dilutions of cypermethrin and left to dry at room temperature. The treated leaves were offered to 3rd instar larvae for 3 days and then replaced with untreated leaves until pupation. Also, the tested concentrations were mixed with the artificial diet according to (Hegazi *et al.*, 1977). Parallel control groups were also run using 3rd instar larvae fed on cotton, castor bean leaves and artificial diet treated with water only. Each concentration was replicated three times, 25 larvae each. The larvae were weighted pre- and post two and four days from treatment. The larval growth rate was determined according Assal (1975):

$$GR = \frac{\text{weight gain of larvae during a feeding period}}{\frac{\text{weight of larvae after feeding} + \text{weight before feeding}}{2}}$$

Also, the larval mortality, larval duration, pupation percent, pupal duration, pupal weight, adult emergence and sex ratio were determined. The results were subjected to analysis of variance (ANOVA) (Knapp and Miller, 1992).

Results

I - Effect of diet on larval mortality, larval duration, larval growth rate, pupation, pupal weight, pupal duration, adult emergence and sex ratio of *Spodoptera littoralis*:-

Results in tables (1-9) show that the effect of the three tested diets (cotton leaves, castor bean leaves and artificial diet) on larval mortality, pupation, pupal duration, pupal weight, adult emergence and sex ratio of *S. littoralis* was insignificant. The most observable biological effects of the diets were on larval duration, and larval growth rate. The larval duration was 17.1, 10.5 and 12.3 days with cotton leaves, castor bean leaves and artificial diet, respectively. The larval growth rate after two days from treatment was 0.81, 1.1 and 0.79 with cotton leaves, castor bean leaves and artificial diet, respectively, while the larval growth rate after four days from treatment was 1.47, 1.67 and 1.46 with cotton leaves, castor bean leaves and artificial diet, respectively. The pupal weights were 186.5, 223.7 and 208.7 mg with cotton leaves, castor bean leaves and artificial diet, respectively.

II - Effect of diets on the potency of cypermethrin against *S. littoralis*:-

a - Larval mortality:-

From the results in table (1), it is obvious that cypermethrin caused high significant mortality with cotton leaves, followed by the artificial diet and castor bean leaves. Also, the larval mortality with the different diets was dose dependent.

b - Larval duration:-

Data obtained (table, 2) show that cypermethrin had insignificantly affected the larval duration with the three tested diets at different concentrations. But at any concentration the larval duration was lower with castor bean leaves, than those with artificial diet and cotton leaves. For example, the larval durations were 11, 13 and 16.1 days with castor bean leaves, artificial diet and cotton leaves, respectively.

c - Larval growth rate:-

Tables (3 and 4) show the larval growth rate after two and four days from treatment. Cypermethrin significantly reduced the larval growth rate at different concentrations with cotton leaves and castor bean leaves after two and four days from treatment. With artificial diet the effect was only significant after 4 days. At any concentration, the larval growth rate was significantly low with cotton leaves, followed by castor bean leaves and lastly artificial diet.

d - Percent pupation:-

Results in table (5) show that the percent pupation had been significantly reduced by increasing the cypermethrin concentration with all the tested diets. At any concentration the percent pupation was insignificantly affected. However it was lower with cotton leaves, followed with artificial diet and lastly castor bean leaves.

e - Pupal weight:-

Data given in table (6) indicate that the most pronounced effect of cypermethrin on pupal weight was with cotton leaves, followed by artificial diet and lastly castor bean leaves. All these effects were significant.

f - Pupal duration:-

Results in table (7) show that cypermethrin significantly prolonged pupal duration with castor bean leaves only. While the prolongation of pupal duration with cotton leaves and artificial diet was insignificant.

g - Adult emergence:-

Data given in table (8) indicate that cypermethrin highly significantly reduced adult emergence with cotton leaves. At any concentration with the three tested diets, the percent of adult emergence was insignificant.

h - Sex ratio:-

The sex ratio of S. littoralis (table, 9) had not been significantly affected by cypermethrin at different concentrations and with different diets.

Discussion

From the aforementioned results it could be concluded that the three tested diets, cotton leaves, castor bean leaves and artificial diet had no determined effect on larval mortality, pupation, pupal duration, pupal weight, adult emergence and sex ratio of *S. littoralis*, but caused delaying effect on larval duration and larval growth rate. Similarly, Mansour *et al.* (1982) studied the effect of the broad bean, the clover and the termis on the cowpea aphid, *Aphis cracciovra*. Ebeid (1993) reported that the royal jelly caused significant increase in the number of eggs deposited by *B. mori* females and caused a significant decrease in the larval duration. Also the total concentration of haemolymph proteins increased markedly in the treated larvae specially in the 4th larval instar. Mostafa and El-Sherif (1993) tested five different plant powders against, *Trogoderma granarium*. The tested powders affected the larval weight. Omar *et al.* (1994) tested the effect of mustard, cabbage, squash and lettuce on the fecundity, longevity, reproductive rate and reproductive period of Myzus persicae. Salama et al. (1995) studied the effect of rearing diet (artificial diet, olive leaves, Jasminium grandiform, J. azoricum, artificial diet + olive oil and artificial diet + dry olive leaves) on the protein of the Jasminium moth, Palpita unionalis. Salama and El-Sayed (1996) reared the corn earworm, Helicoverpa zea and the tobacco budworm, Heliothis virescens on

artificial diet, cotton and corn. In both types of insects, the highest concentration of proteins accumulated in the gut and fat body of the larvae fed on corn more than either cotton or artificial diet. Abou El-Ela et al. (1997) studied the effect of different foods (grapes, lettuce, gnidium and artificial diet) on some biological activities of Lobesia botrana. Lettuce significantly shortened the life cycle of the moth, followed by grapes and gnidium. El-Sayed et al. (1998) studied the effect of three additives (Treache, fenugreek seed extract and dry yeast), three foliar nutrients (polymex, potasin F and citric acid and their mixtures) on 5th larval instar of Bombyx mori. Khedre (1998) mentioned that the pupal weight resulted from different larval media deprived from beef meet was significantly reduced. However, high level of cholesterol decreased pupal weight of Wohlfahrtia nuba. El-Gindi (2000) reported that the concentration of the monovalent and divalent cations in the haemolymph of S. littoralis larvae was significantly affected by the host plant on which the larvae were reared. They were much in blood of larvae fed on berseem as compared to the other three tested host plants (cotton, castor oil and root beet). Zohdy et al. (2000) stated that the growth rate of S. littoralis was higher when reared on berseem leaves followed by castor oil and cotton leaves. Roy et al. (2002) described the purification of mannose-blinding lectins from three different monocotyledon plants (Allium sativum, Colocasia esculenta and Diffenbachia sequina) and their effects on the red cotton bug. All of them had a detrimental effect on the growth and development of the insect. A. sativum bulb lectin showed the highest mortality of all. The same bulb lectin not only affected the growth and fecundity of the insect but also imparted drastic changes in the color, weight and size, even on the second generation of the insects which

have been reared on artificial diet supplemented with a sublethal dose of the lectin. According to Nurindah and Tiongson (2001) the larval diets affected the number and length of femoral "brush" scales in male H. punctigera moth.

The three tested diets affected the potency of cypermethrin against *S. littoralis* larvae, especially on larval mortality, larval duration, larval growth rate and pupal weight. These results agree with the findings of El-Sayed (1982) who studied the effect of the type of host plant and the part of the neem tree from which the extract was made, on the potency of neem against *S. littoralis*. When larvae were fed for 3 days on cotton leaves treated with 0.2 and 0.5% of seed suspension, mortality throughout the larval stage was 55 and 77.5%, respectively, as compared to 90 and 100% on treated clover leaves to 30 and 100% on treated castor bean leaves. Also, Sadek (1998) studied the intact leaves or crude leaf extracts of the water hyacinth, *Eichhornia crassipes* on the growth rate and mortality of *S. littoralis*. All larvae fed on the leaves of *E. crassipes* died after three weeks, very slow growth, their body weight did not exceed 1.07% of the weight of larvae fed on artificial diet or susceptible host plant (castor bean) leaves. Carlini *et al.* (1997) stated that, Canatoxin is a toxic protein isolated from jackbean, *Canavalia ensiformis*, seven insect species were fed on canatoxin-containing diets. The data showed that canatoxin is highly toxic when ingested by some species of insects but not affecting others, probably in correlation with the characteristics of the digestive process of the insect. Olsen and Daly (2000) studied the plant toxin interactions in transgenic Bt cotton and their effect on mortality of *H. armigera*. They reported that LC_{50} depending on the source of toxin and conventional plant material. Bell *et al.* (2001)

stated that the cowpea trypsin inhibitor (CPTI) has a deleterious effect on the growth and development of larvae of the tomato moth, *Lacanobia oleracea*, when incorporated in artificial diet and in transgenic potato leaf.

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Table (1): Effect of diet on the potency of Cypermethrin on larval mortality of *Spodoptera littoralis*.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
	% mortality	% mortality	% mortality	
0.0	6.0	5.0	4.0	> 0.05 NS
0.01	57.0	44.0	53.0	< 0.05*
0.10	73.0	51.0	65.0	< 0.05**
1.00	100.0	70.0	80.0	< 0.05**
10.00	100.00	100.0	100.0	-
P	< 0.05*	< 0.05*	< 0.05	

Table (2): Effect of diet on the potency of Cypermethrin on larval duration of Spodoptera littoralis.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
	$\bar{x}$ ± S.E (days)	$\bar{x}$ ± S.E (days)	$\bar{x}$ ± S.E (days)	
0.0	17.11 ± 0.85	10.50 ± 0.27	12.33 ± 0.33	< 0.05**
0.01	16.15 ± 0.40	11.00 ± 0.19	13.00 ± 0.27	< 0.05*
0.10	15.03 ± 0.15	11.57 ± 0.34	13.25 ± 0.44	< 0.05*
1.00	-	12.73 ± 0.71	13.33 ± 0.52	> 0.05 NS
10.00	-	-	-	-
P	> 0.05 NS	> 0.05 NS	> 0.05 NS	

Table (3): Effect of diet on the potency of Cypermethrin on larval growth rate of *Spodoptera littoralis* after 2 days from treatment.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
0.0	0.81	1.10	0.79	< 0.05*
0.01	0.49	0.53	0.79	< 0.05*
0.10	0.31	0.50	0.76	< 0.05*
1.00	0.01	0.24	0.71	< 0.05**
10.00	0.004	0.05	0.49	< 0.05**
P	< 0.05*	< 0.05*	> 0.05 NS	

NS : Non significant
* : Significant.
** : Highly significant.

Table (4): Effect of diet on the potency of Cypermethrin on larval growth rate of *Spodoptera littoralis* after 4 days from treatment.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
0.0	1.47	1.67	1.46	> 0.05 NS
0.01	1.30	1.49	1.43	> 0.05 NS
0.10	1.14	1.47	1.28	< 0.05*
1.00	0.58	1.31	1.14	<0.05**
10.00	-	0.74	1.10	< 0.05*
P	< 0.05*	< 0.05*	< 0.05*	

Table (5): Effect of diet on the potency of Cypermethrin on pupation of *Spodoptera littoralis*.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
	% pupation	% pupation	% pupation	
0.0	94.0	95.0	96.0	> 0.05 NS
0.01	43.0	56.0	47.0	> 0.05 NS
0.10	27.0	49.0	35.0	> 0.05 NS
1.00	0.0	30.0	20.0	> 0.05 NS
10.00	0.0	0.0	0.0	-
P	< 0.05**	< 0.05**	< 0.05*	

Table (6): Effect of diet on the potency of Cypermethrin on pupal weight of *Spodoptera littoralis*.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
	$\bar{x}$ ± S.E (mg)	$\bar{x}$ ± S.E (mg)	$\bar{x}$ ± S.E (mg)	
0.0	186.54 ± 0.16	223.77 ± 0.16	208.79 ± 0.28	>0.05 NS
0.01	179.95 ± 0.13	215.83 ± 0.13	207.22 ± 0.17	< 0.05*
0.10	160.76 ± 0.22	213.26 ± 0.15	200.69 ± 0.24	< 0.05*
1.00	-	202.73 ± 0.18	197.32 ± 0.28	> 0.05 NS
10.00	-	-	-	-
P	< 0.05*	< 0.05*	< 0.05*	

NS : Non significant
* : Significant.
** : Highly significant.

Table (7): Effect of diet on the potency of Cypermethrin on pupal duration of *Spodoptera littoralis*.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
	$\bar{x}$ ± S.E (days)	$\bar{x}$ ± S.E (days)	$\bar{x}$ ± S.E (days)	
0.0	10.56 ± 0.37	9.65 ± 0.23	10.0 ± 0.64	> 0.05 NS
0.01	11.87 ± 0.17	10.05 ± 0.41	10.22 ± 0.22	> 0.05 NS
0.10	12.25 ± 0.34	11.40 ± 0.43	10.44 ± 0.44	> 0.05 NS
1.00	-	12.75 ± 0.55	11.77 ± 0.70	> 0.05
10.00	-	-	-	
P	> 0.05 NS	< 0.05*	> 0.05 NS	

Table (8): Effect of diet on the potency of Cypermethrin on adult emergence of *Spodoptera littoralis*.

Conc. (ppm)	Diets			P
	Cotton leaves	Castor bean leaves	Art. diet	
	% adult emergence	% adult emergence	% adult emergence	
0.0	89	91	92	> 0.05 NS
0.01	84	89	88	> 0.05 NS
0.10	70	84	84	< 0.05*
1.00	-	72	75	> 0.05 NS
10.00	-	-	-	-
P	< 0.05**	> 0.05 NS	< 0.05*	

Table (9): Effect of diet on the potency of Cypermethrin on sex ratio of *Spodoptera littoralis*.

Conc. (ppm)	Diets					
	Cotton leaves		Castor been leaves		Art. diet	
	Male	Female	Male	Female	Male	Female
0.0	0.97	1.03	1.03	0.97	1.16	0.84
0.01	0.90	1.10	0.90	1.10	1.11	0.89
0.10	0.83	1.17	0.88	1.12	1.07	0.83
1.00	-	-	0.97	1.03	1.09	0.81
10.00	-	-	-	-	-	-
P	> 0.05 NS		> 0.05 NS		> 0.05 NS	

NS : Non significant
* : Significant.
** : Highly significant.

الملخص العربى

تأثير نوع الغذاء على كفاءة السيبرميثرين ضد دودة ورق القطن الكبرى سبودوبترا ليتورالس (حرشفية الأجنحة – نوكتويدى)

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تم إجراء دراسات معملية لمعرفة تأثير ثلاثة أنواع مختلفة من الغذاء هى ورق القطن، وورق الخروع وبيئة صناعية وتأثير هذه الأنواع المختلفة من الغذاء على كفاءة السيبرميثرين على المظاهر البيولوجية المختلفة لدودة ورق القطن الكبرى سبودوبترا ليتورالس.

ولقد أوضحت النتائج أن تأثير أنواع الغذاء المختبرة على موت اليرقات، ونسبة التعذر، وطول عمر العذارى، ووزنها وخروج الحشرة البالغة والنسبة الجنسية كان غير معنوياً، ولكن التأثير الواضح كان على طول العمر اليرقى، ومعدل النمو اليرقى.

كما أوضحت النتائج تأثير أنواع الغذاء المختبرة على كفاءة السيبرميثرين من حيث موت اليرقات، ومدة العمر اليرقى، ومعدل النمو اليرقى، ووزن العذارى بينما لم تتأثر نسبة التعذر ومدة الطور العذرى ومعدل خروج الحشرات البالغة والنسبة الجنسية بشكل معنوى. ولقد أثرت أوراق الخروع على كفاءة السيبرميثرين يليها البيئة الصناعية بينما أحدثت أوراق القطن مع السيبرميثرين أفضل تأثير.