EFFECT OF BACILLUS THURINGIENSIS ON APANTELES RUFICRUS PARASITIZING THE LARVAE OF AGROTIS YPSILON

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SUMMARY: The interaction between the insect pest, Agrotis ypsilon; the parasite, Apanteles ruficrus and the pathogen Bacillus thuringiensis has been investigated. A. ruficrus parasitizing on host larvae treated with B. thuringiensis showed significant reduction in the egg production, formed cocoons, longevity of either sex and emerged adults. The mortalities caused by B-exotoxin were increased among parasitized host larvae more than the unparasitized ones.

Key Words: Bacillus thuringiensis, agrotis ypsilon.

INTRODUCTION

The relation between the bacterial pathogen, Bacillus thuringiensis and the parasites of some insect pests has been investigated by several authors (3,5,6). They studied the deleterious effects caused by the pathogen to the parasites. In Egypt, a serious of investigations has been carried out to explore the possible interrelation between, the pathogen B. thuringiensis and the parasites of some insect pests (7-9,12-14).

In the present work, investigations have been carried out to determine the effect of the pathogen B. thuringiensis S-endotoxin on the larval parasite Apanteles ruficrus, associated with the greasy cutworm Agrotis ypsilon.

In addition, the effect of B-Exotoxin (thuringiensis) on the parasite has also been demonstrated.

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MATERIALS AND METHODS

Effect of B. thuringiensis on A. ruficrus : The effect of B. thuringiensis on the parasite was assessed by two different methods. In the first method, 100 newly moulted 3rd instar larvae of A. ypsilon were fed on artificial diet (1) containing B. thuringiensis at 500 μg/ml concentration. The larvae were then exposed to mated females of the parasite. In the second method, 100 host larvae were fed on fresh artificial diet (1) and then exposed to mated females of the parasite fed 10% honey solution containing B. thuringiensis Kurstaki, HD1 at the rate of 500 μg/ml. In the control, the host larvae were raised on untreated diet and exposed to the untreated parasites fed on 10% honey solution. In all cases, the exposure of larvae lasted for 24 hours at the rate of one couple of the parasite for each 10 host larvae.

Effect of B-exotoxin (thuringiensin) on A. ruficrus : Different concentrations of thuringiensin (provided by Abott Laboratories) (63, 125, 250 and 500 ppm) were prepared. The host diet was prepared according to Abdel-Salam, with the omission of auromycin. For each concentration 50 larvae were used. Larvae were separated and maintained at 26°C and 55% R. H. Mortality records were made after 7 and 14 days. The emerged adults of the parasite were isolated for further observations.

Table 1: Effect of B. thuringiensis on the biology of the endoparasite A. ruficrus reared on larvae of A. ypsilon.

ýItem	Untreated parasites	Parasites fed on	
		Host larvae treated with B.t.	Diet with B. thuringiensis
No of parasitized host larvae	5.8 ± 0.38	5.6 ± 0.36	5.20 ± 0.81
Adult longevity in days, females	9.3 ± 0.62	9.1 ± 0.57	8.80 ± 0.57
Adult longevity in days, males	6.8 ± 0.42	6.8 ± 0.40	6.00 ± 0.38
Number of deposited eggs/female	25.7 ± 1.42	24.9 ± 1.17	23.1 ± 1.08
Duration (egg-pupa) in days	18.0 ± 1.32	26.2 ± 2.74	24.80 ± 1.42
% formed cocoons/host larvae	33.3	12.7	19.6
% of emerged adults	75.5	14.3	49.3
Longevity of emerged adult females	8.9 ± 0.94	5.2 ± 0.38	6.30 ± 0.71
Longevity of emerged adult males	6.0 ± 0.38	3.3 ± 0.30	4.30 ± 0.72

RESULTS

Apanteles ruficrus (HaII.) is gregarious internal braconid parasite of many noctuid larvae including the greasy cutworm Agrotis ypsilon (2,4,17).

Effect of B. thuringiensis on A. ruficrus: The number of larvae of A. ypsilon that have been parasitized by A. ruficrus was not affected whether the adult parasite was fed on honey solution containing B. thuringiensis or when the host larvae were fed on a diet treated with the pathogen. In the control, the average number of host larvae parasitized by a single Apanteles female was 5.8, compared to an average of 5.6 and 5.2 individuals after treating the host larvae and adult parasites by B. thuringiensis. The adult longevity showed insignificant changes as a result of treatment being 9.3 and 6.8 days for the normal females and males, compared to 8.8 and 6.0 days, respectively, after feeding females and males on honey with the pathogen. The longevity of adult parasites feeding on treated larvae also showed no obvious differences compared with the control (Table 1).

The egg production of A. ruficrus females was not affected as a result of both treatments when compared with the untreated individuals. Thus, the average egg production was 24.9 and 23.41 eggs/female for individuals parasitizing treated host larvae or adult parasites fed on B. thuringiensis, respectively, compared with an average of 25.7 eggs for the control female. The duration of the immature stages of the parasite (egg-pupae) was significantly prolonged as a result of treatment of the host larvae or feeding the parasite females on a diet containing B. thuringiensis, being 26.2 and 24.8 days compared with 18.0 days in the control. The percentage of parasites that completed their development on treated A. ypsilon larvae showed to be 12.7%, while it was 19.6% in case of treatment of the adult parasite with the pathogen, this is compared with 33.3% in the control.

Table 2: Susceptibility of unparasitized and A. ruficrus parasitized A. ypsilon larvae to B-exotoxin (thuringiensin).

State of host larvae	No of days after treatment with B-exotoxin	LC_{50} of B-exotoxin in ppm
Unparasitized host larvae + B-exotoxin	7	131.52
Parasitized host larvae + B-exotoxin	7	146.88
Unparasitized host larvae + B-exotoxin	14	61.20
Parasitized host larvae + B-exotoxin	14	64.86

Table 3: Effect of B-exotoxin (thuringiensin) on unparasitized and A. ruficrus parasitized A. ypsilon larvae.

B-exotoxin conc. (ppm)	% mean mortality	
	Unparasitized	Parasitized
None	16	71
63	27	92
125	38	89
250	73	95
500	95	98

The emergence of the adult parasites was affected as a result of treatment by B. thuringiensis, where 14.3 % emergence occurred from treated parasitized host larvae compared to 75.5 % from the resulting cocoons in the control. Feeding the parasite on honey containing B. thuringiensis inhibits adult emergence being 49.3 %. On the other hand, a marked decrease was observed in the longevity of the parasites obtained from treated host larvae being 5.2 and 3.3 days for females and males, respectively. The average longevity of parasites fed on a diet containing the pathogen were less affected being 6.71 and 4.3 days for females and males, respectively, compared with an average of 8.9 and 6.0 days in the control (Table 1).

Effect of B-endotoxin (thuringiensin): The dosage mortality response to B-exotoxin (thuringiensin) for the Agrotis ypsilon larvae, showed that the 7-day-LC_{50} values for unparasitized and parasitized individuals were 131.52 ppm and 146.88 ppm, while the 14-day-LC50 values for unparasitized and parasitized individuals were 61.20 and 64.86 ppm, respectively (Table 2).

Table 3 illustrates, A. ypsilon larval mortalities after various treatments over the entire period of the host larval development. The unparasitized (control) larvae incurred 16% mortality during the entire life span, compared to 71% in the parasitized group.

The data indicate that the combined effect of thuringiensin and parasitism, showed an obvious increase than if treated with thuringiensin alone, especially at concentrations of 63, 125 and 250 ppm, where 92, 89 and 95 compared to 27, 38 and 73, respectively.

The effect of thuringiensin on A. ruficrus is presented in Table 4. In untreated larvae, cocoons of the parasite were formed after 12.5 days compared to 12.9, 13.6, 13.9 and 16.8 days of parasitized-thuringiensin treated larvae at the concentrations of 63, 125, 250 and 500 ppm.

In the untreated A. ruficrus, adults emerged from cocoons after 16.5 days, compared to 18.1 and 19.5 days of cocoons of parasitized-thuringiensin treated larvae at concentrations of 250 and 500 ppm, respectively (Table 4).

The foregoing results revealed that, treatment of the host larvae A. ypsilon with B. thuringiensis did not change their susceptibility to parasitism by A. ruficrus. The longevity of the adult parasite and its egg production showed no obvious differences as a result of the

Table 4: Effect of B-exotoxin treatment of A. ypsilon host larvae on the development of the parasite A. ruficrus.

B-exotoxin conc. (ppm)	No of host larvae	A. ruficrus cocoons		A. ruficrus adults	
		Total no.	Mean formation time (days)	Total no.	Mean emergence time (days)
None	100	67	12.5 ± 1.17^a	38	16.5 ± 1.26^a
63	100	39	12.9 ± 1.28^a	20	16.8 ± 1.62^a
125	100	20	13.6 ± 1.42^a	7	17.3 ± 1.34^a
250	100	7	13.9 ± 0.73^a	4	18.1 ± 1.60^a
500	100	3	16.8 ± 1.13^b	2	19.5 ± 1.27^b

Means of each column followed by the same letter are not significantly different at 5% level.

treatment compared with the control. The duration of the immature stages of the parasite was significantly prolonged as a result of feeding the host larvae or the parasite on a diet with B. thuringiensis. The formation of cocoons and the emergence of the adults were markedly decreased.

Investigations showed that the exotoxin (thuringiensin) causes similar effects like B. thuringiensis on the parasite.

Results obtained on the interrelation between the pathogen and the parasites Microplitis demolitor, Zele chlorophthalma, Trichogramma evanescens and Bracon brevicornis showed significant reduction in the egg production, formed cocoons, emerged adults and their longevities (7,8,10,11,13). Previous histopathological studies on the larvae of Spodoptera littoralis showed that the pathogen caused changes in the fat bodies and some other organs which are necessary to the normal development of the parasite (7,8).

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