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INFLUENCE OF HOST'S DIET ON LARVAL PARASITOIDS OF THE FALL ARMYWORM, SPODOPTERA FRUGIPERDA J. SMITH (LEPIDOPTERA: NOCTUIDAE); 1- COTESIA (APANTELES) MARGINIVENTRIS CRES. (HYMENOPTERA: BRACONIDAE)

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ABSTRACT

Since changes in diet-mediated quality of herbivores have an effect on the survival and development of their parasitoids, the aim of this work is the study the influence of nicotine, as plant allelochemical, on the Fall Armyworm Spodoptera frugiperda and on its internal larval parasitoid Cotesia (Apanteles) marginiventris under laboratory conditions when it was added to the host-diet. Host and parasitoid rearing methods were described.

In general, the durations of immature stages of the host and the parasitoid prolonged on the treated diet with nicotine. Significant influence was recorded between the two types of diet (control and nicotine) on the durations of immature stages of the host as well as that of the parasitoid and also on percent of emergence and adult weight of the parasitoid in the first generation.

Sex ratio, adult longevity and durations of immature stages of the second generation showed no significant difference between the two diets.

INTRODUCTION

In most of the available studies no cause and effect relationships are established between changes in diet-mediated quality of herbivores and variation in the survival and development of their parasitoids. Number of studies have noted that parasitoid development differs when the diet of the host herbivore changes (Altantawy et al. (1976), Zohdy (1976), Smith (1978), Campbell and Duffey (1979), Greenblatt et al. (1981) and Barbosa et al. (1982)).

This study will focus on the influence of nicotine, as plant allelochemical, within the host, on internal parasitoids to complete our initial studies on the external parasitoid Euplectrus platyhypenae (Hymenoptera: Eulophidae).

The Fall Armyworm (FAW) Spodoptera frugiperda was used as a host for the experiments. It occasionally feeds on tobacco, so it is sensetive to the nicotine variations. The FAW internal larval parasitoid Cotesia (Apanteles) marginiventris (Kunnalaca and Mueller (1979) and Loke et al. (1973) and (1984) was used to examine the effect of nicotine on its biology under laboratory conditions.

MATERIAL AND METHODS

1- Host rearing:

Adults FAW were reared in a cylindrical screen cage, covered with wrapped sheets of white paper towelling that serve as oviposition sites. The towel was changed daily. Collected eggs were placed in Mason Jars and kept in an incubator at 27°C ± 2°C, at a photoperiod of 8 hours dark and 16 hours light, and a R.H. of 50% ± 5%. Neonate larvae were placed singly in plastic cups (3/4 OZ) onto Bio Serve FAW diet either regular or nicotine diet depending on treatment. The cups were kept under the mentioned laboratory conditions till pupation. Nictince diet was prepared during the preparation of the regular diet by mixing the desired concentration of nicotine directly with the mixture. The 0.025% (wet weight) of nicotine was selected (based on preliminary studies as the concentrations providing substantial survival of the herbivores and within the normal concentration range in host plants.

2- Parasitoid rearing:

Up to 200 neonate FAW larvae were placed in a 16 OZ plastic cup with a transparent clear plastic lid. The larvae were supplied with cubes of Bio Serve FAW, either regular or nicotine diet depending on treatment and exposed to the parasitoid. Several adults of Cotesia were introduced into this parasitization chamber.

Following parasitization, the larvae were transferred to a Mason jar with cubes of diet for a period of seven days. The seven days period allowed to distinguish parasitized from unparasitized larvae. The parasitized larvae were then transferred to 3/4 OZ plastic cups containing diet (2-3 larvae/each) till spinning cocoons and emergence of adults. The Mason jars as well as the plastic cups were kept under the previous mentioned laboratory conditions. Adults of the parasitoid were maintained in a transparent plastic sweater box "10 x 12 x 4". This cage was kept in a rearing chamber at 22°C ± 2°C with a photophriod of 9 hours dark and 15 hours light and a R.H. of 45% ± 5%. Honey was dispensed dropwise on the inside top of the cage to serve as adult food. Required data were recorded daily.

RESULTS AND DISCUSSION

1- Influence of nicotine diet on the host:

The duration of immature stages of S. frugiperda when fed on either regular or 0.025% nicotine diet under laboratory conditions are presented in Table (1).

Table 1: Duration of immature stages of S. frugiperda under laboratory conditions when fed on regular and nicotine diet.

Stage	Duration in days	
	Regular diet	Nicotine diet
Larva	13.65 ± 0.15 (12 - 15)	17.88 ± 0.30** (15 - 21)
Pupa	8.71 ± 0.11 (8 - 10)	8.92 ± 0.14 (8 - 10)
Total developmental period	22.25 ± 0.21 (21 - 25)	26.67 ± 0.18** (24 - 30)

** Highly significant difference at P. > 0.01

Statistical analysis (t-test) of the obtained data on the duration of immature stages showed a highly significant difference between both feeding diets, especially the larval and total developmental periods, while there was no difference in pupal period; pupal weight (0.1839 g./pupa) and sex ratio (1:1) were recorded.

2- Influence of nicotine diet on the parasitoid:

2-1. Duration of immature stages (first generation):

The duration of various stages of Cotesia marginiventris when parasitizing S. frugiperda, that fed on regular or 0.025% nicotine diet under laboratory conditions of 27°C ± 2°C, a photoperiod of 8,16 hours dark and light, respectively and a R.H. of 50% ± 5% are presented in Table (2).

Table 2: Duration of different stages of C. marginiventris under laboratory conditions when its host was bed on regular and nicotine diet.

Stage	Duration in days	
	Regular diet	Nicotine diet
Eggs	2.71 + 0.20 (2 - 3)	2.63 ± 0.18 (2 - 3)
Larvae		
First instar	1.86 ± 0.28 (1 - 3)	2.33 ± 0.21 (2 - 3)
Second instar	2.33 ± 0.33 (1 - 3)	2.17 ± 0.30 (1 - 3)
Third instar	3.00 ± 0.25 (2 - 4)	3.40 ± 0.24 (3 - 4)
Total Egg & Larval period	10.13± 0.08 (9 - 11)	10.52± 0.15* (9 - 13)
Prepupae	>1 - 1	>1 - 1
Pupae	4.47 ± 0.07 (4 - 5)	4.84 ± 0.12** (4 - 6)
Total developmental period	14.5 ± 0.11 (13 - 16)	15.25± 0.24++ (13 - 19)

* Significant differ

In general, recorded data in Table (2) indicates that most of the durations of immature stages of C. marginiventris that fed on nicotine diet lasted longer than that on regular diet.

Statistical analysis (t - test) of the data between both feeding types showed a significant difference between them in the total larval period as well as highly significant one in the pupal and total developmental periods, while no other significant difference was obtained among the larval instars.

Another effect of the host treated with nicotine was relatively clear on the lower percent of parasitoid emergence after spinning their cocoons. This percent was 91.4% in the control and decreased to 84.4% in the treatment with nicotine.

In addition, another influence was observed in the adult weight (dry weight). The mean averaged 0.386 Mg. and 0.350 Mg. for females and males, respectively, in the case of control, while it averaged less in the case of nicotine diet. It was 0.315 Mg. and 0.305 Mg. for females and males, respectively.

In agreement with our results Kunnalaca and Mueller (1979) and Greenblatt et al (1981) stated that variation in allelochemicals leads to changes in parasitoid survival and development, size, sex ratio, percent parasitism, fecundity and percent emergence.

Also, the same significant influence of nicotine on the duration of immature stages was found by the author on the FAW internal larval parasitoid, Hyposoter annulipes (Hymenoptera: Ichneumonidae) when the same circumstances were used, while no significant influence was obtained in the case of the external larval parasitoid, Euplectrus platyhpenae How. (El-Heneidy 1985). Barbosa et al. (1982) reported that different influences of allelochemicals on the parasitoids were affected by the feeding habits and sites of the larval parasitoids.

2-2. Duration of immature stages (second generation):

On the contrary of the first generation on the 0.025% nicotine diet was the second one. Available data were 10.36 ± 0.15, 4.55 ± 0.16 and 14.91 ± 0.25 for larval, pupal and total developmental periods, respectively, in the second generation under the same laboratory conditions. Statistical analysis revealed no significant differences among the data of the second generation between the control and nicotine diet.

This could be interpreted that some internal parasitoids get rid of their nicotine load by shunting most of the nicotine into the cocoon silk (produced by larvae) and into the meconium left behind within the cocoon as adults emerge (Barbosa et al. 1982). Another interpretion might be the detoxification of plant toxins by some parasitoids to non toxic substances, such as the change of nicotine to continine (Barbosa et al. 1982).

2-3. Sex ratio:

The mean sex ratio between the adults of C. marginiventris emerged under laborarory conditions was 1 ♀ : 1.2 ♂ on regular diet and 1 ♀ : 1.3 ♂ and 1 ♀ : 1.7 ♂ from nicotine diet in the first and second generations, respectively.

2-4. Longevity:

In general, no difference was observed between the adults of C. marginiventris under the above mentioned laboratory conditions on both types of diet, the mean of longevity was 26.3 ± 0.86 (ranged 20 - 31) on regular diet and 26.8 ± 1.68 (ranged 20 - 35) on nicotine diet.

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