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Studies on Mass Culturing of *Heliothis armigera* (Hbn.) (Noctuidae: Lepidoptera) on Semi - Synthetic Diets. II. Effect on the Development of Pre-imaginal Instars

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ABSTRACT

Two semi-synthetic diets were studied with reference to their effect on the development of the pre-imaginal stages of gram pod borer, *Heliothis armigera*. Incubation period was not at all influenced while the larval period was found to be reduced by 50 to 60 per cent from that on lab-lab. The number of instars in the larval stage was reduced to five in the second generation on diet-A, while in the others it was only six in both the generations. Increase in length and weight of larvae was evidenced consequent to intake of semi-synthetic diet. While the prepupal period was shorter on natural hosts, the total period was markedly shorter and pupal weight distinctly greater on artificial diets. The total life-cycle as such was also found to be shortened, especially in the second generation in all the diets.

INTRODUCTION

The success in any artificial rearing of insects depends on the extent to which the total life-cycle is shortened so that more generations could be cultured in a unit period. Shortening in the developmental period could be tangibly attained in the pre-imaginal instars, even to the extent of reduction in number of larval instars, by dietetic changes as reported on *Heliothis armigera* (Hbn.) by Minanandana (1964) and on the castor semi-looper *Achaea janata* L. by Boonyank (1964). Earlier the authors (1973) have successfully developed two semi-synthetic diets for mass-culturing of *Heliothis armigera* and the present paper deals with the observations made on the development of the pre-imaginal instars of the insect in two generations as compared with that of two sources of natural hosts.

MATERIALS AND METHODS

Freshly hatched first instar larvae were transferred to the semi-synthetic diets made of Bengal gram flour, yeast, ascorbic acid, agar and distilled water as well as to their natural hosts, viz. tomato and lablab. Small quantity of semi-synthetic diet required for one day's feeding was kept in a 2 x 2 cm filter paper and placed inside a 7.5 x 2.5 cm specimen tube. With a view

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to avoiding cannibalism only a single larva was placed inside each tube. Early instar larvae were fed as per the method adopted by Atallah and Newsom (1966) for rearing the grubs of the Coccinellid, *Coleomegilla maculata* De Geer. After preparation, the semi-synthetic diet was poured while still hot, into the specimen tubes directly to a depth of one cm. After the medium got solidified and cooled, newly hatched larvae were placed singly in the specimen tubes and kept upside down. This method was more hygenic and further reduced contamination, decay and desiccation of the diet. In the case of tomato, small bits of fruits were kept in polythene sheet and for rearing on lab-lab, seeds were soaked for 24 hours in water, macerated to a fine paste with water and placed in a filter paper for rearing the first two instars as they could not be successfully reared with the entire seed. However, full seeds were used for the latter instars of caterpillars.

Diets were changed daily in the morning and observations were made daily on the moulting of the caterpillars. Moulted skins and head capsules were easily observed from third instar onwards, head capsules could only be detected by observing under a stereozoom microscope. Data regarding the number of larval instars, larval and pupal periods, their size and weight were also gathered on each of the diets. Length of the caterpillars was measured on the day of hatching and on alternate days thereupon till they pupated. After pupation, pupal lengths were recorded. The larvae were weighed on the tenth day after hatching and at the time of the last moult. The pupal weights were also recorded immediately after pupation.

RESULTS AND DISCUSSION

(i) Incubation period

The incubation period was three days in all the diets and the same was observed by Vanderzant *et al.* (1962) for the same species cultured on a wheat germ diet.

(ii) Larval period

Except for the first instar the duration of other five instars was found to be shortened in the larvae grown in diets A and B. The mean larval period in insects reared on diet-A was 15.9 days in two generations. The duration was prolonged to 18.6 days in diet-B, 19.3 days in tomato and it was as high as 26 to 27 days in Lab-lab. Shorey and Hale (1965) reared *Heliothis armigera* caterpillars within 14.8 days on a dry beans medium, while Chauthani and Adkisson (1965) were able to rear the same species in 18.3 and 18.7 days in wheat germ and alfalfa meal diets respectively. The average larval period reported by Patel *et al.* (1968) was 20.7 days for *Heliothis armigera* (Hbn.). There were no differences observed on the external features of the caterpillars reared on semi-synthetic diets and natural hosts, excepting for the colour during first three instars. The larvae were yellow when reared on semi-synthetic diets, while they were pink on tomato resembling somewhat the fruit colour.

(iii) Number of larval instars

There were six distinct larval instars observed in all the diets, viz., tomato, Lab-lab and the semi-synthetic diets A & B in the first generation. But the number of instars was reduced to five in the second generation in diet-A. This enabled the insects reared on it to complete the larval development much faster when compared to these reared on either tomato or Lab-lab or diet-B. The previous workers who reared *Heliothis armigera* or for that matter, any other insect on semi-syntehetic diets, have not reported any such reduction in the number of instars.

(iv) Size of the larva

The size of larva in diet-A reached a maximum length of 36.4 mm on the 17th day i.e., at the end of their development whereas the larvae reared on other diets viz., Tomato, *Lab-lab* and diet-B reached the lengths of 36.6, 33.5 and 30.0 mm respectively on 19th, 27th and 19th days. The increase in length of the caterpillars was gradual in the natural hosts but distinctly rapid in the case of the diets A & B, especially during the last two instars. In the second generation the behaviour of the larva to the diets was much more pronounced, the diet-A resulting in a mean length of 39.7 mm on 13th day itself, this being the greatest length achieved in the shortest period when compared to all other diets. A percentage of weight increase of 675.6 and 156.4 mg in ten day old larva was recorded in diets A & B from *Lab-lab*. The mean weight recorded on tenth day by the caterpillars varied from 183.70, 60.70, 77.24 and 23.68

TABLE 1. Effect of diets on the weight of the ten day old caterpillar of *Heliothis*

Diet	Weight per larva (mg) I Generation	II Generation	Mean
Diet-A	47.00	320.40	183.70
Diet-B	26.60	94.80	60.70
Tomato	62.24	92.24	77.24
Lab-lab	21.28	26.08	23.68
Mean	39.28	133.38	

Comparison of significant effects

	Levels of significance	C. D.
1. Between diets	(P=0.001)	11.98
Conclusion : Diet-A, Tomato, Diet-B, Lab-lab		
2. Between generation	(P=0.001)	8.47
Conclusion : Generation II, Generation I		
3 Interaction	(P=0.001)	16.93

ing by diet A, B, tomato and *Lab-lab* respectively (Table 1). Similar results were obtained by Mc Morran (1965) and Leonard and Donae (1966) who reared the Spruce bud worm, *Choristoneura fumiferana* Clem. and the gypsy moth, *Porthetria dispar* L. respectively on semi synthetic diets.

(v) Prepupa and Pupa

The mean prepupal period was 2.5 days in first generation (Table 2.a)

TABLE 2 a. Effert of diets on the prepupal period of *Heliothis*

Diet	I Generation (Days)	II Generation (Days)	Mean
Diet-A	2.79	2.40	2.60
Diet-B	2.39	2.15	2.27
Tomato	2 24	2.05	2.15
Lab-lab	2 40	2.33	2 37
Mean	2.46	2.23	

while the same was reduced to 2.2 days in second generation. Generally, the prepupal period was found to be shortened on natural hosts than on semi-synthetic diets. Besides soil, the larvae pupated readily in cotton mass also without any difficulty, after forming a cocoon around it. The duration of pupa was 10.9 days in both the diets A & B, as against 11.7 days in *Lab-lab* (Table 2.b) It was reported

TABLE 2 b. Effect of diets on the pupal period of *Heliothis*

Diet	I Generation (Days)	II Generation (Days)	Mean
Diet-A	11.05	10.84	10.96
Diet-B	11.44	10.50	10.97
Tomato	11.09	10.45	10.77
Lab-lab	11.80	11.52	11.66
Mean	11.35	10.83	

TABLE 2 c. Effect of diets on the pupal weight of *Heliothis*

Diet	I Generation	II Generation	Mean
Diet-A	243.16	251.00	247.08
Diet-B	222.22	251.00	236.61
Tomato	202.29	209.00	205.65
Lab-lab	185.50	186.67	186.09
Mean	214.29	224.40	

TABLE 3. Effect of diets on the total life cycle of *Helithois* in two generations

Diet	I Generation (days)	II Generation (days)	Mean
Diet-A	34.16	30.68	32.42
Diet-B	37.28	32.12	34.70
Tomato	35.96	34.32	35.14
Lab-lab	44.20	43.72	43.96
Mean	37.90	35.21	

Comparison of significant effects :

	Level of Significance	C. D (P = 0.05)
1. Between diets	(P=0.001)	1.37
Conclusion : Diet-A, Diet-B, Tomato, Lab-lab		
2. Between Generations	(P=0.001)	1.13
Conclusion : Generation II, Generation I		
3. Interaction	(P=0.01)	1.98

to be 12.2 days by Patel *et al.* (1968), 12.5 days by Shorey and Hale (1965) and 17 days by Chauthani and Adkisson (1965) for the same *Heliothis* on semi-synthetic diets. Increase in the weight of the pupa to the extent of 32 and 27 per cent respectively in diets A & B over the Lab-lab also indicate the high suitability of these semi-synthetic diets for the insect. (Table 2 c)

(vi) Total life-cycle

The life-cycle was comparatively shorter on all the diets in the second generation but the decrease was marked in insects cultured in diets A and B (Table 3).

Diet-A served as the most suitable among all the four, whereas Lab-lab prolonged the life-cycle by 10 days when compared to diet-A. Diet-B and tomato were on par in their effects on total life-cycle. The total life-cycle of *Heliothis armigera* was 32.4 days in diet-A and 34.7 days in diet-B, while it was 35.1 days in tomato and 43.9 days in *Lab lab*. Shorey and Hale (1965) reported a duration of 30 days on artificial diets. But according to Chauthani and Adkisson (1965) the total life-cycle was found to be 38 days on semi-synthetic diets.

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