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Feeding and development of *Spodoptera litura* larvae on different cotton varieties

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Abstract: Feeding and development of *Spodoptera litura* larvae were observed on CB9, CB10 and SR05 cotton varieties. The varieties showed significant effect on the amount of larval food consumption and development duration. The 1st, 2nd, 3rd and 4th instar larvae consumed the highest amount of food (140.9, 777.5, 1823.0 and 2201.0 mg, respectively) as well as produced highest amount of excreta (3.1, 23.9, 58.5 and 87.9 mg, respectively) when they were reared on SR05 variety whereas the 5th instar larval food consumption (4724.0 mg) and excreta production (443.3 mg) was found highest on CB10 variety. The 1st and 2nd instar larvae showed longer durations (10.0 and 6.7 day, respectively) on SR05 variety whereas 3rd, 4th and 5th instar larvae had longer duration (7.3, 5.3 and 7.3 day, respectively) on CB10 variety. It was found that the 2nd and 4th instar larval dry weight varied significantly and their highest weights (6.8 and 27.1 mg, respectively) were found on CB10 and CB9 variety, respectively. The information generated through this study could contribute in the development of management programme of *S. litura*.
Key words: Cotton, *Spodoptera litura*, larva, variety.

Introduction

Cotton armyworm, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae), an economically serious pest of cotton is reported to attack 120 species of host plants belonging to 44 families (Pogue, 2003). Many cotton varieties possessed defense mechanism against pest infestation. Varieties with significant levels of tannins disrupt feeding and growth of chewing insects. The densities of trichomes on the buds and leaves surface deter feeding and oviposition. Kamel (1965) reported that cotton cultivars with increased trichomes density on lower leaf surface were more resistant to cotton leaf worm, *S. littoralis*. The cotton varieties had possessed trichome densities 70 / 13.7 mm^2 of leaf surface declined the population of whitefly and leafhopper (Butler *et al*., 1991). The morphological characteristics such as leaf shape, hairiness, bract shape and the presence or absence of nectar producing glands on leaves or flowers, and physical or structural qualities of host plant interfere with insect feeding behaviour. Maternal diet is considered an important factor for optimal insect growth (McIntyre and Gooding, 2000; Agrawal, 2001) and duration of offspring development (Roff, 1992).

Cotton growers of Bangladesh usually spray insecticides throughout the season to protect their crops from armyworm attack. But this kind of control strategy is directly toxic to the beneficial insects (Goodland *et al*., 1985), and this pest has developed resistance against a wide range of insecticides (Armes *et al.*, 1997). For taking efficient and sustainable management strategy of any Lepidopteran pest, knowledge on the larval feeding behaviour and host characteristics are very important. Therefore, with a view to gain knowledge for proper management of *S. litura*, this study was designed to assess the amount of food consumption, production of excreta and development duration of larvae on three cotton varieties that possessed different morphological characteristics.

Materials and Methods

Collection and rearing of insect: The study was conducted in the Entomology Laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during September 2008 to February 2009 maintaining 25 ± 2 ^oC and 60 ± 5% RH. Adult male and female moths were collected from the cotton field of the Regional Cotton Research Station, Dinajpur and they were kept in paired in petridishes (9.0×1.5 cm) for mating. Every morning, fresh cotton flowers of the variety CB9, CB10 and SR05 were supplied into the petri-dishes as food for the moths. After completion of mating, the male moths were removed from the petri-dishes and the females were kept separately in jars (26.5×13.5cm) for oviposition. Cotton leaves and flowers were supplied into the jars. Every morning the petri-dishes were cleaned and monitored to observe the egg mass. After hatching, fresh cotton leaves were supplied into the jars for food of the young larvae till pupation.

Observation of larval development: The larvae passed through five instars with four moults. The first instar larvae were pale green and possessed two black spots on the head. They had soft mandibles and they preferred only young shiny leaves. The second instar larvae came out by leaving the exuviae of the first instar which were increased in size. The third instar larvae were more active and fed more food and were larger than the second instar and became more pale green in colour. The fourth instar larvae were darker dorsally and possessed a dark lateral stripe. The fifth instar larvae turned grey and usually with a conspicuous yellow line down each side of the back and became giant.

Measurement of food consumption: Amount (g) of leaf consumption and production of excreta within 24 hours by each larval instar was measured by using a Mettler digital balance (Model- MR 220, No. 971373). One newly hatched larva was placed in each petri dish (9.0 × 1.5 cm) with medium matured leaves. The initial weight of the supplied leaves was recorded. To find out the weight of consumed leaves in 24 hours (A), the weight of unused leaves (C) and the weight of moisture loss from the control petridish (D) were subtracted from the initial weight of supplied leaves (B). Calculation can be as follows: A = B - (C + D).

Measurement of excreta weight: For measurement of excreta, a newly hatched larva was reared in a petridish (9.0 × 1.5 cm) with fresh cotton leaf. Each larval excreta was collected daily and that was measured by a Mettler digital balance (Model- MR 220, No. 971373). Total amount of excreta produced by a larval instar was

calculated. This method was replicated 4 times for each variety.

Measurement of larval dry weight: The full grown larvae were dried in an incubator at 60 ^{o}C for three days and then their weights were measured by a Mettler digital balance (Model- MR 220, No. 971373). Measurement of larvae for each cotton variety was replicated 5 times.

Data analysis: Data were analyzed by analysis of variance and the mean values were separated by Duncan's Multiple Range Test (DMRT). All the analyses were performed by using PASW Statistics 18.

Results

Larval duration: Cotton varieties have significant effect on the durations of 1st, 2nd, 3rd, 4th and 5th instar larvae and the durations varied from 7 .5 ± 0.5 to 10.0 ± 1.4, 5.7 ± 0.9 to 6.7 ± 0.9, 3.3 ± 0.5 to 7.3 ± 1.3, 3.3 ± 0.5 to 5.3 ± 0.9 and 4.3 ± 0.9 to 7.7 ± 0.9 day, respectively (Table 1). The 1st instar larval period was found highest to the variety SR05 and the lowest period on the variety CB10. The 2nd instar larval period appeared highest and lowest when the larvae fed CB9 and CB10 variety, respectively. The 3rd instar larval period was found highest on the variety CB10 and the lowest appeared on the variety CB9. The highest and lowest larval period of 4th instar were found on the varieties CB10 and CB9, respectively. The 5th instar larval period was observed highest and lowest when they fed CB9 and SR05 varieties.

Table 1. Duration of larval instars (mean ± SD day) of *S. litura* feeding on different cotton varieties

Varieties	Larval period (day)				
	1st instar	2nd instar	3rd instar	4th instar	5th instar
CB9	8.3 ± 0.9 b	6.3 ± 0.5 a	3.3 ± 0.5 b	3.3 ± 0.5 b	7.7 ± 0.9 a
CB10	7 .5 ± 0.5 b	5.7 ± 0.9 ab	7.3 ± 1.3 a	5.3 ± 0.9 a	7.3 ± 0.9 a
SR05	10.0 ± 1.4 a	6.7 ± 0.9 a	5.7 ± 1.3 ab	3.7 ± 0.5 b	4.3 ± 0.9 b

Means within a column followed by no common letter (s) are significantly different (DMRT, $p \leq 0.05$)

Table 2. Total amount (mean ± SD mg) of food consumed by larval instars of *S. litura* reared on different cotton varieties

Varieties	Amount (mg)				
	1st instar	2nd instar	3rd instar	4th instar	5th instar
CB9	98.5 ± 12.4 b	479.0 ± 33.7 b	557.6 ± 30.5 b	870.9 ± 35.2 c	4644.0 ± 81.4 ab
CB10	73.7 ± 11.7 b	131.4 ± 24.3 c	686.7 ± 44.9 b	1194.4 ± 43.8 b	4724.0 ± 89.6 a
SR05	140.9 ± 13.2 a	777.5 ± 49.2 a	1823.0 ± 63.7 a	2201.0 ± 68.5 a	3456.0 ± 66.8 b

Means within a column followed by no common letter(s) are not significantly different (DMRT, $p \leq 0.05$)

Table 3. Amount (mean ± SD mg) of excreta produced by different larval instars of *S. litura* reared on different cotton varieties

Varieties	Amount (mg)				
	1st instar	2nd instar	3rd instar	4th instar	5th instar
CB9	2.9 ± 2.4 a	22.7 ± 10.8 a	39.6 ± 14.9 b	79.3 ± 25.5 ab	410.0 ± 159.5 b
CB10	2.4 ± 2.1 ab	14.4± 6.4 b	35.3 ± 8.3 b	68.4 ± 38.1 b	443.3 ± 50.8 a
SR05	3.1 ± 2.8 a	23.9 ± 16.4 a	58.5 ± 29.0 a	87.9 ± 38.6 a	393.3 ± 118.5 b

Means within a column followed by no common letter(s) are not significantly different (DMRT, $p \leq 0.05$)

Table 4. Dry weight (mean ± SD mg) of different instar of *S. litura* larvae fed on different cotton varieties

Varieties	Larval instar				
	1st	2nd	3rd	4th	5th
CB9	1.9 ± 0.8 a	5.3 ± 0.3 ab	11.6 ± 0.7 a	27.1 ± 1.6 a	39.0 ± 1.3 a
CB10	1.9 ± 0.7 a	6.8 ± 0.5 a	11.7 ± 0.4 a	26.0 ± 2.4 ab	39.9 ± 1.5 a
SR05	2.1 ± 0.7 a	5.5 ± 0.3 ab	11.3 ± 0.6 a	25.7 ± 2.0 ab	39.1 ± 0.7 a

Means within a column followed by no common letter(s) are not significantly different (DMRT, $p \leq 0.05$)

Food consumption: Daily food consumption by different larval instars have presented in figure 1. Results showed that the larvae started feeding just after hatching but consumed very little amount of food until 3 day old and later it was increased. The 1st, 2nd, 3rd and 4th instar larave reared on SR05 variety showed highest food consumption (35, 175.4, 384.2 and 708.2 mg, respectively) at their age of 7, 6, 4 and 3day, respectively. The 5th instar larvae reared on CB10 variety consumed the highest amount (864.4 mg) at the age of 5 day. Larval food consumption abruptly decreased at the day before moulting. Total amount of food consumed by the 1st, 2nd, 3rd, 4th and 5th instar larvae ranged from 73.7 ± 11.7 to 140.9 ± 13.2, 131.4 ± 24.3 to 777.5 ± 49.2, 557.6 ± 30.5 to 1823.0 ±

63.7, 870.9 ± 35.2 to 2201.0 ± 68.5 and 3456.0 ± 66.8 to 4724.0 ± 89.6 mg, respectively (Table 2). The 1st, 2nd, 3rd and 4th instar larvae consumed significantly the highest amount of food when they were reared on SR05 variety, whereas the 5th instar larvae consumed the highest amount of food when they were provided with CB10 variety.

All the larval instars showed significant difference in their production of excreta (Table 3). The amount of excreta peoduced by 1st, 2nd, 3rd, 4th and 5th instar larvae varied from 2.4 ± 2.1 to 3.1 ± 2.8, 14.4 ± 6.4 to 23.9 ± 16.4, 35.3 ± 8.3 to 58.5 ± 29.0, 68.4 ± 38.1 to 87.9 ± 38.6 and 393.3 ± 118.5 to 443.3 ± 50.8 mg, respectively. The highest amount of excreta produced by 1st, 2nd, 3rd and 4th instar larvae were found when they were reared on SR05 variety, whereas the 5th instar lavae produced highest amount of excreta when they were reared on CB10 variety.

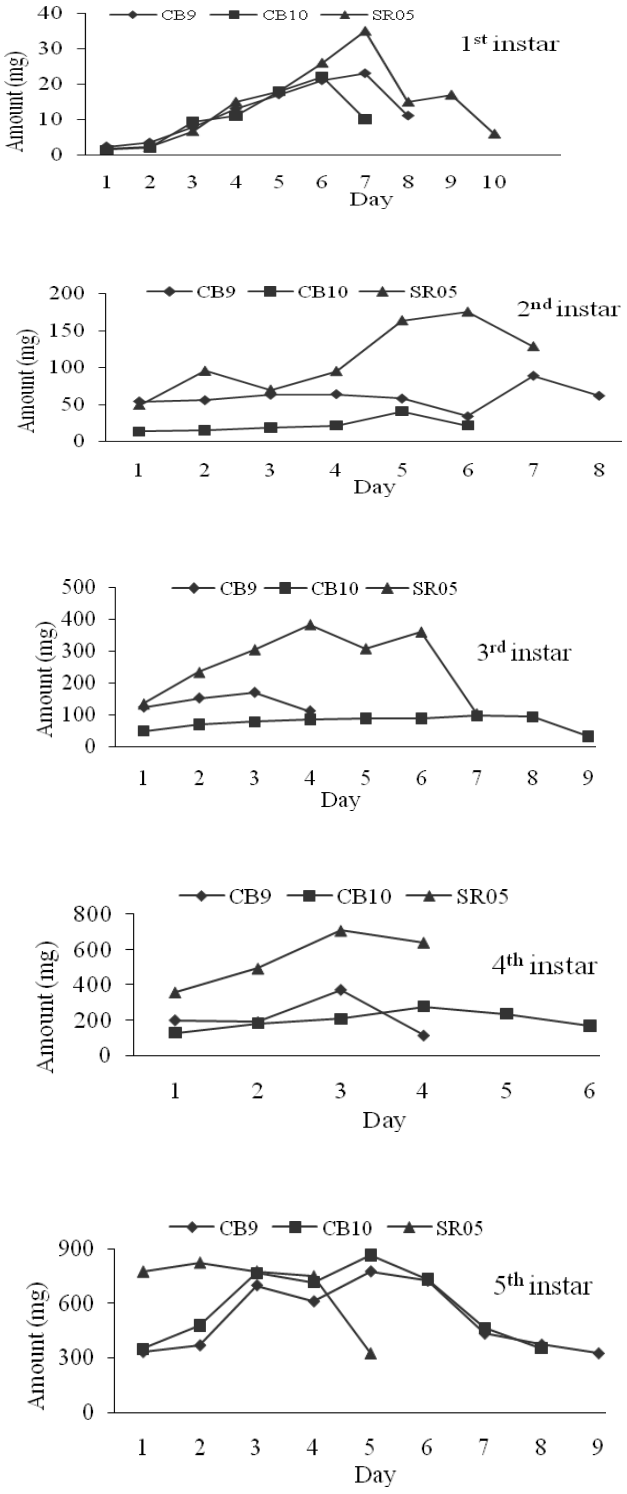

Fig. 1. Daily food consumption of different larval instars of *S. litura* reared on different cotton varieties

Table 4 showed that cotton varieties had no significant effect on the dry weight of 1st, 3rd and 5th instar larvae, whereas 2nd and 4th instar larvae showed significant variation. The 2nd instar lavae that fed CB10 variety revealled the highest weight (6.8 ± 0.5 mg), whereas the 4th instar larvae that were reared on CB9 variety revealled the highest weight (27.1 ± 1.6 mg).

Discussion

This study demonstrated that the cotton varieties have significant effect on the durations of 1st, 2nd, 3rd, 4th and 5th instar larvae of *S. litura*. This result showed agreement with Sakamoto *et al*. (2004) who reported that food quality effect on the development duration of *S. litura.* They found that the larvae reared on soybean leaves developed faster compared to eddo leaves. Seth and Sharma (2001) found shorter larval duration on castor leaves compared to checkpea seeds. On the other hand, Sintim *et al*. (2009) found longer larval duration on sesame leaves compared to an artificial diet. The *S. litura* larvae reared on CB9, CB10 and SR05 cotton varieties showed variation in their feeding behavior. The morphological characteristics of the plant such as presence of hair and trichome may effect on their feeding. Larval feeding behavior demonstrated that food consumption increased with increasing instars. Dieter (2001) studied the feeding behavior of herbivorous insects and reported that hrbivorous insect adopt different feeding strategies throughout their life cycle. Reed (1974) observed that frego bract cottons were least attacked by *Earias* spp. Food consumption rates of *S. exigua* were studied with five host plants viz. cabbage, cotton, bell pepper, pigweed and sunflower, and mean leaf weight consumed by larvae was the highest in cabbage and the lowest in pigweed (Greenberg *et al*., 2001). The amount of excreta produced by different larval instars indicated that the 1st to 4th instar larvae produced higher amount of excreta on SR05 and 5th instar on CB10. It may be a general phenomenon that the larvae consumed higher amount of food produced higher amount of excreta. Dhandapani *et al*. (1985) observed the food consumption of *S. litura* larvae reared on three cotton varieties, three chilli varieties and on castor leaves. They reported that the larvae consumed significantly different amount of food when they were reared on three cotton varieties. They also reported that the larvae consumed the highest amount (5.34 g) of food when they were reared on castor leaves. Influence of host plant on insect growth and development has been reported by many authors (Stevenson *et al*., 1993; Eigenbrode *et al*. 1995). Larval feeding behaviour and development on host plant indicate the relative susceptibilities of crop varieties to pest infestation. This was clearly shown by Tamaru (1998) in folivorous larvae. In this study it was found that the cotton varieties CB9, CB10 and SR05 have significant effect on feeding and development of *S. litura* larvae that might be an information for the cotton growers for taking management decision.

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