Foraging Behavior of *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) First Instar Larvae on Selected Cotton Varieties

Md. Ruhul Amin\(^1\), H. M. Saifullah Azad\(^2\), Md. Shamim. Hossain\(^1\), Sang Jae Suh\(^3,4\), and Yong Jung Kwon\(^{1,4,5}\)

\(^1\)Department of Entomology, Bangabandhu Sheikh Mijibur Rahman Agricultural University, Gazipur 1706, Bangladesh
\(^2\)Regional Cotton Research Station, Dinajpur 5200, Bangladesh
\(^3\)School of Applied Biosciences, Kyungpook National University, Daegu 702-701, Korea
\(^4\)Institute of Plant Medicine, Kyungpook National University, Daegu 702-701, Korea

Received: September 16 2014 / Revised: October 14 2014 / Accepted: October 14 2014

**Abstract** The movement, survival, and weight gain of *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) first instar larvae were studied on CB9, CB10 and SR05 cotton varieties under field conditions. The neonate *H. armigera* were released on the cotton varieties at the squaring stage of the plants and, after a period of 72 hours, the survival, weight gain, and final location of the larvae were observed. While the different cotton varieties had no effect on the survival and weight gain of the larvae, the release locations on the cotton varieties had a significant influence on the larval survival and weight gain. The larvae fed small squares of the cotton varieties were significantly heavier and showed a higher mortality than the larvae fed leaflets and mature leaves. For the cotton varieties in this study, the larvae released on leaflets showed a significantly higher rate of recovery compared to the larvae released on mature leaves and squares. This study also found that that the larvae on leaflets did not move up or downward unlike the larvae on mature leaves and squares. This information on the foraging behavior of larvae on cotton varieties will assist researchers to interpret field data and thereby help with the development of pest management decisions.

**Keywords:** Cotton variety, *Helicoverpa armigera*, larval movement

**Introduction**

Cotton is a highly valued cash crop in Bangladesh, where the widely cultivated varieties include CB9, CB10, and SR05. While CB9 is a long height (115.0 cm), bushy, and hairy variety with trichomes 193/cm\(^2\), CB10 is a short height (88.3 cm) and smooth variety, and SR05 is a well ventilated and slightly hairy variety with trichomes 106/cm\(^2\) (Amin et al., 2008; Amin et al., 2011).

Every year a number of sucking and chewing insect species attack these cotton varieties and cause significant crop loss. Among these insect species, the polyphagous insect *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) is one of the most significant cotton pests in Bangladesh (Amin et al., 2008). Their larvae have been reported to feed on over 130 plant species worldwide (Matthews, 1999), initially eating the tender leaves close to where they hatch and then moving upwards to the reproductive organs (Zalucki et al., 2002).

*Caterpillars can spend more time for processing a feeding site on leaves with a heavy layer of wax or many trichomes, as they have to remove these obstacles to access more nutritious layers. Furthermore, thick blooms of wax can gum up the larval mouthparts, which then need to be cleaned before the larvae can continue feeding. This pre-processing and preening increases the*
amount of time spent at risk of predation. The surface of the leaves also affects the way the larvae deposit silk on the plant (Varela and Bernays, 1988). The larvae of *H. armigera* deposit silk continuously as they walk across the plant and before they feed (Sorensen et al., 2006). This then affects the larval adherence and locomotion across the leaf surface, as the legs of the larvae can become tangled with the silk threads (Varela and Bernays, 1988), impeding locomotion, and can be hampered by wax crystals (Eigenbrode and Shelton, 1992) or trichomes (Zalucki et al., 2002).

Selecting the proper variety and protecting the crops from pests and diseases are important prerequisites for a higher yield and quality of cotton. Therefore, this study investigated the foraging behaviour of *H. armigera* first instar larvae on the morphologically different cotton varieties of CB9, CB10, and SR05. The resulting data on the foraging behavior of *H. armigera* first instar larvae on these varieties provides basic information on the most vulnerable stage of *H. armigera* with a view to providing information to cotton growers and researchers for proper management of this pest.

Materials and Methods

The study was conducted at the Regional Cotton Research Station, Dinajpur, Bangladesh from August to December 2012.

Collection and rearing of insects

The adult male and female *H. armigera* moths were collected from the Cotton Research Station, Dinajpur. The moths were kept in pairs in Petri dishes (9.0×1.5 cm) for mating. Every morning, a fresh cotton flower was supplied to the Petri dishes as food for the moths. The Petri dishes were continuously examined to observe mating. After the completion of mating, the male moth was removed from the Petri dish and the female kept in a jar (26.5×13.5 cm) for oviposition. Cotton leaves and flowers were supplied to the jar. Every morning the jars were cleaned and monitored to observe the egg mass and hatching of eggs. The neonate larvae were used for the experiments.

Observation of foraging behavior

To observe the foraging behavior of the *H. armigera* first instar larvae, the CB9, CB10, and SR05 cotton varieties were grown in earthen pots. The foraging behavior of the larvae was repeated twelve times for each variety using 40-50-day-old-plants (early squaring stage). To test the first instar larval growth and survival, and the feeding locations on the cotton varieties, 10 0-4-h-old larvae were inoculated onto each plant in one of three starting positions: on the upper surface of the top immature leaf or on a mature leaf on the first fruiting branch or square of the plant. For each experiment, 40 larvae were weighed individually to obtain an initial average weight. After 72 h, each plant was carefully searched to recover the live larvae, note their positions, and measure their weights.

Results

Table 1 shows that a total of 360 neonates were placed on each cotton cultivar. After 72 h, a total of 126, 121, and 134 live larvae were recovered from the CB9, CB10, and SR05 variety, respectively. Thus, the overall survival rates for these varieties were, 35.0, 33.6, and 40.3%, respectively, which showed no significant difference ($\chi^2$=1.0, $p=0.61$). The larval weight gains on the CB9, CB10, and SR05 varieties were 159.3×10$^{-5}$, 144.8×10$^{-5}$, and 176.5×10$^{-5}$, respectively.

Table 2. Effect of release site (leaflet, mature leaf, or small square) on number and location of first instar *Helicoverpa armigera* larvae recorded after 72 h exposure on CB9, CB10, and SR05 cotton varieties

<table>
<thead>
<tr>
<th>Variety</th>
<th>Release Site</th>
<th>Total no. released</th>
<th>Number and locations of larvae collected after 72 h</th>
<th>Total no. and rate recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Folded leaflet</td>
<td>Unfolded leaflet</td>
</tr>
<tr>
<td>CB9</td>
<td>Leaflet</td>
<td>120</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Mature leaf</td>
<td>120</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Small square</td>
<td>120</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>CB10</td>
<td>Leaflet</td>
<td>120</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Mature leaf</td>
<td>120</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Small square</td>
<td>120</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>SR05</td>
<td>Leaflet</td>
<td>120</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Mature leaf</td>
<td>120</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Small square</td>
<td>120</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

A leaflet is the upper part of a terminal leaf; mature leaf on the first fruiting branch, and square on the first fruiting branch.
Young Lepidoptera larvae generally display a replicable foraging behavior moving up their host plant (Perkins et al., 2008). The nitrogen and water contents of food are important determinants of young caterpillar performance (Zalucki et al., 2002). Thus, since the leaves in the lower/older plant regions contain the least proportion of nitrogen and seem to be of least nutritive value, the larvae move up the plant.

The leaflet hardness varied considerably among the cotton varieties used in this study. As a result, hardness was discounted as a macro-level factor influencing the movement of the first instars. However, the hardness of the plant components likely influenced the movement on a local (micro) scale, where the hard plant parts were “ignored” as a potential food source and the larva moved on until softer plant tissue was encountered. Thus, the movement of young caterpillars on plants is assumed to be a variable between Lepidoptera species and between host plants.

The polyphagous insect considered in the current study is one of the most damaging pests for field crops in Bangladesh, and chemical insecticides have traditionally been used to control this pest. Yet this management technology disrupts the environment, and the renewed emphasis on sustainable, environment-friendly crop protection practices has highlighted the need to develop alternative pest management strategies. Accordingly, the present study generated important data that can hopefully be used for the development of integrated management of *H. armigera* in the cotton fields of Bangladesh.

### References


