BOLLWORM DAMAGE AND BEHAVIOR IN BT COTTON

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Abstract

Studies were conducted to determine larval feeding preferences and the amount of damage done to fruiting forms between non-Bt and Bt cotton. Early observations pertaining to the incorporation of Bt and its effects on bollworm larvae stated that surviving larvae would detect and avoid high expressing regions of the plant. Current issues with resistance in bollworm populations have led to larvae being more tolerant to these high expressing plant regions. Therefore, studies were performed to evaluate the current feeding preferences of bollworm larvae on Bt and non-Bt plant tissues by using bioassays. Under the controlled feeding setting, no significant differences were observed between feeding preferences of larvae over various time intervals. An additional study was conducted to evaluate the damage done between non-Bt and Bt cotton fruiting forms. The study evaluated damage on a per larva basis. The results from the study suggest that the only significant difference in damage between non-Bt and dual gene Bt cotton is based on square damage.

Introduction

Bollworm, *Helicoverpa zea* (Boddie), is a major lepidopteran pest that is noted to feed on over 100 host plants (King and Coleman 1989). Early populations can be established in various wild host species. As agricultural crops are are planted and reach susceptible stages, bollworm populations begin to increase in these crops. In cotton, the primary concern is during fruit development stages. Bollworm larvae feed on the various fruiting forms. This may result in fruit abscission and an overall reduction in yield. During the early years of Bt cotton, primarily dual-gene cotton, control of bollworm populations and prevention of fruit loss was effective. Studies showed that when comparing fruiting form damage of non-Bt to that of Bollgard and Bollgard II, there was a significant decline in damage to fruiting forms along with rapid larval movement down the plant in Bt cotton (Gore et al. 2002). An additional study was conducted through the use of bioassays that used multiple Bt infused diet disks and one untreated disk. During the study, it was observed that larvae were selective feeders, meaning that they sought out a food source lacking in Bt before searching for an alternative (Gore et al. 2005). Given the current status of resistance to one or multiple Bt proteins by bollworm, larval behavior in Bt cotton needs to be revisited.

Materials and Methods

Studies were conducted during the summer of 2018 to evaluate damage done to fruiting forms on a per larva basis. Strip plots were planted on 23 May using Deltapine 1822XF, Deltapine 1646 B2XF, and Deltapine 1835 B3XF. Plot size was 4 rows (40 in. centers x 40 ft.). A total of 3 replicates were completed over time for this experiment. Upon reaching 5 nodes above white flower, individual cotton plants were isolated to prevent interplant movement of larvae. A single flower (first position) was infested with an individual 2-day old larva using a small artists paintbrush. Observations were made at 3, 7, 9, and 11 days after infestation to determine the amount of fruiting form damage per larva. Data from this experiment was analyzed with analysis of variance (PROC GLIMMIX, SAS ver. 9.4) with a 95% confidence interval.

An additional study was conducted using bioassays. The experiment consisted of pulling leaves and small squares from the upper canopy of the varieties previously mentioned, with the exception of Deltapine 1835B3XF. A small cork-borer was then used to punch holes in leaves of the various varieties to provide leaf disks. Leaf disks (2) from both varieties were place in self-sealing petri dishes (50 x 9mm). 2 day old larvae were individually placed into 5-cm petri dishes with self-sealing lids. The same method was used for the square study. However, only 1 non-Bt square and 1 square from Bollgard II were placed in the self-sealing petri dishes. Observations were made at 24, 48, and 96 hours after infestation to determine changes in feeding preferences over time. The data obtained was subjected to a Chi Square analysis.

Results

The cumulative damage of fruiting forms varied between non-Bt and Bollgard II varieties. However, upon evaluation of damage to specific fruiting forms, there was no significant difference between boll damage of non-Bt and Bollgard II. Square damage however, did differ significantly between the varieties. No larvae were observed at the 3 day observation time in Bollgard 3 (Figure 1). When comparing fruiting form damage between the years 2000 and 2018, there is a noticeable increase in boll damage that occurs in Bollgard II (Figure 2). Also square damage has increased between the dates (Figure 3). Proportionally speaking, square damage in Bollgard II, in the year 2000, was 1% of the non-Bt. Square damage, proportioned to non-Bt, has increased to 33% in Bollgard II as of 2018.

Observations of larval feeding preferences over time concluded with similar results between bioassay studies. The incorporation of non-Bt and Bt leaf tissue did not significantly influence larval feeding behavior over the time periods (Figure 4). Also when observing feeding preferences for non-Bt and Bt squares, the same results were observed (Figure 5). The differentiation in the observation at the 24 hour period, for both bioassay studies, was due to a number of larvae not selecting a food source. Once the 48 hour observation was met, the majority of the larvae had found a food source. Larvae were observed as feeding at random or moving to the nearest food source, rather than selectively choosing one source (non-Bt) over the other (Bt).

Overall, damage in transgenic cotton, expressing *Bacillus thuringiensis* proteins, has succumbed to higher levels of fruiting form damage. Based on these studies, bollworm larvae have become more tolerant to higher expressing regions of the plant. Also, previously mentioned selectivity for feeding may be less probable or potentially non-existent for two-gene cotton varieties expressing Bt.

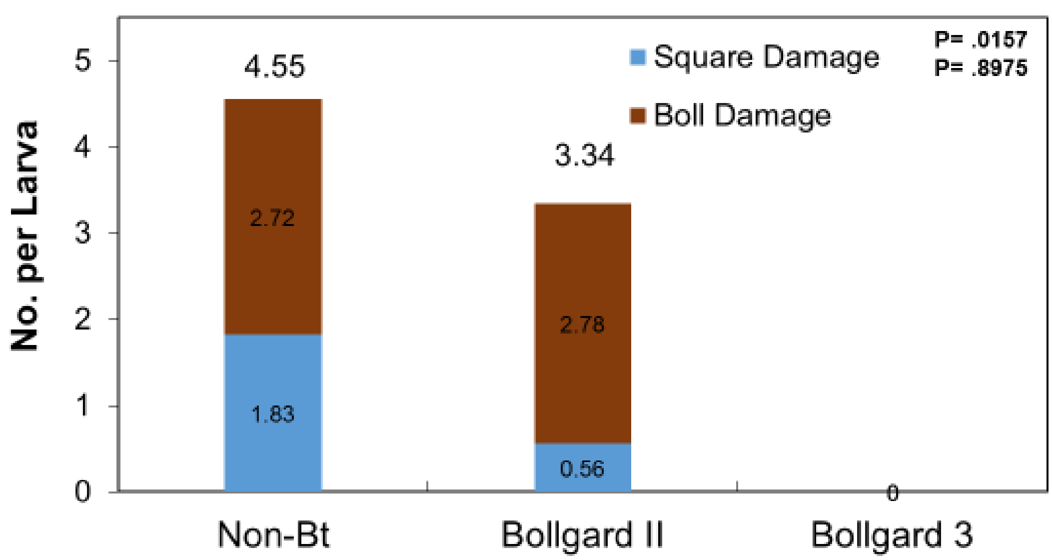

Figure 1. Cumulative fruiting form damage per larvae.

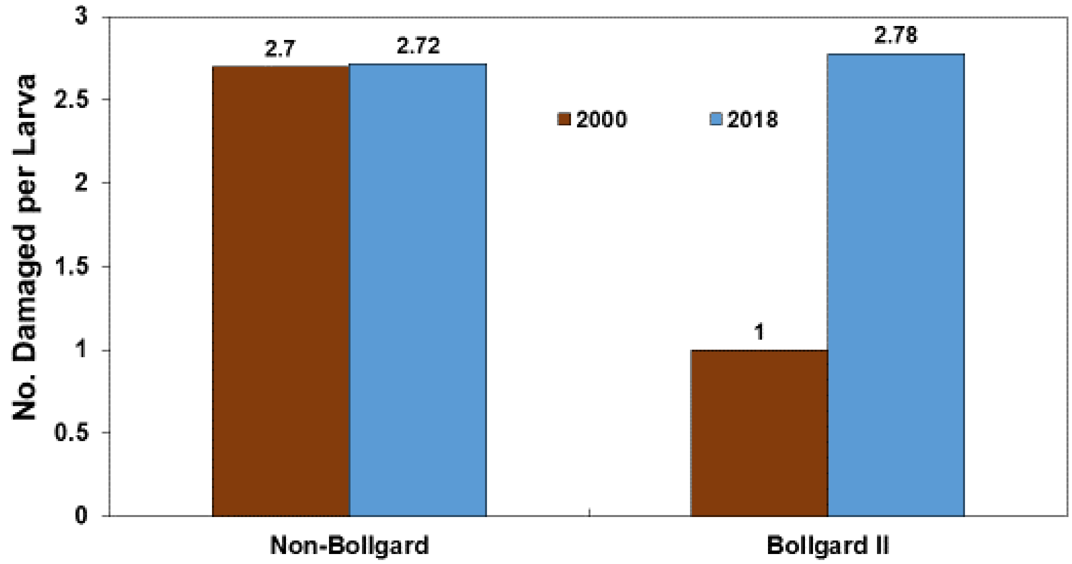

Figure 2. Cross examination of boll damage per larvae between the years 2000 and 2018.

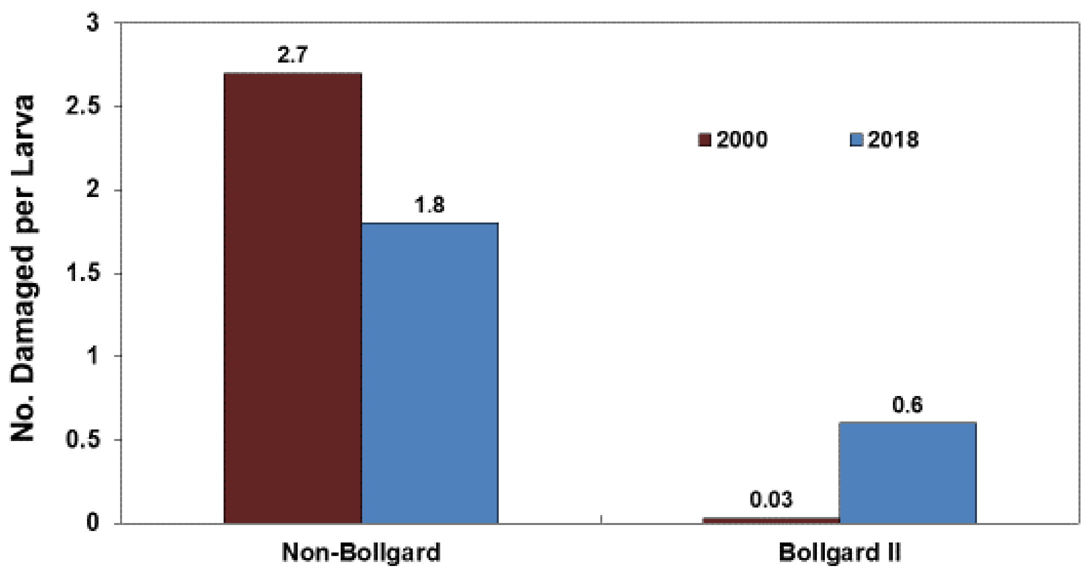

Figure 3. Cross examination of square damage per larvae between the years 2000 and 2018.

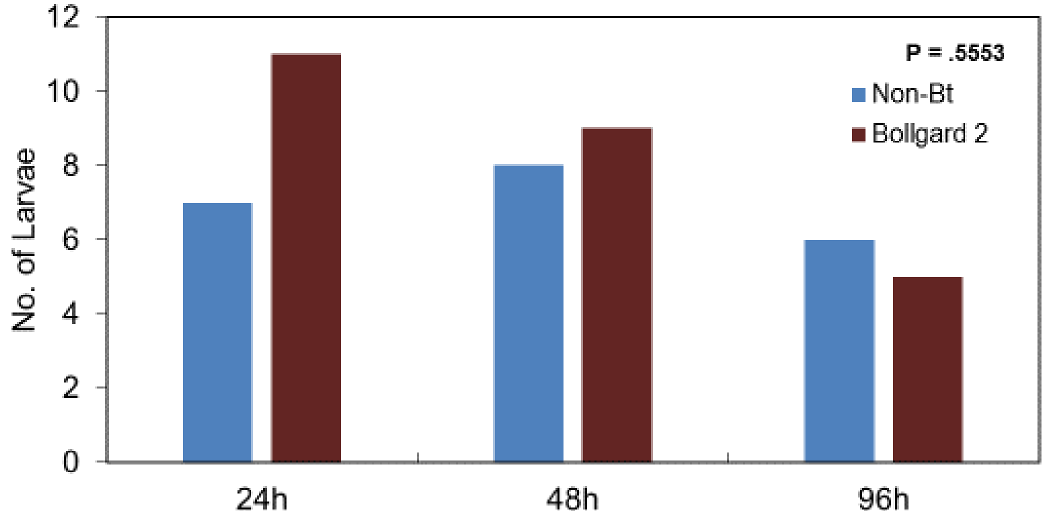

Figure 4. Distribution of larvae on Non-Bt and Bt leaf tissues over time intervals.

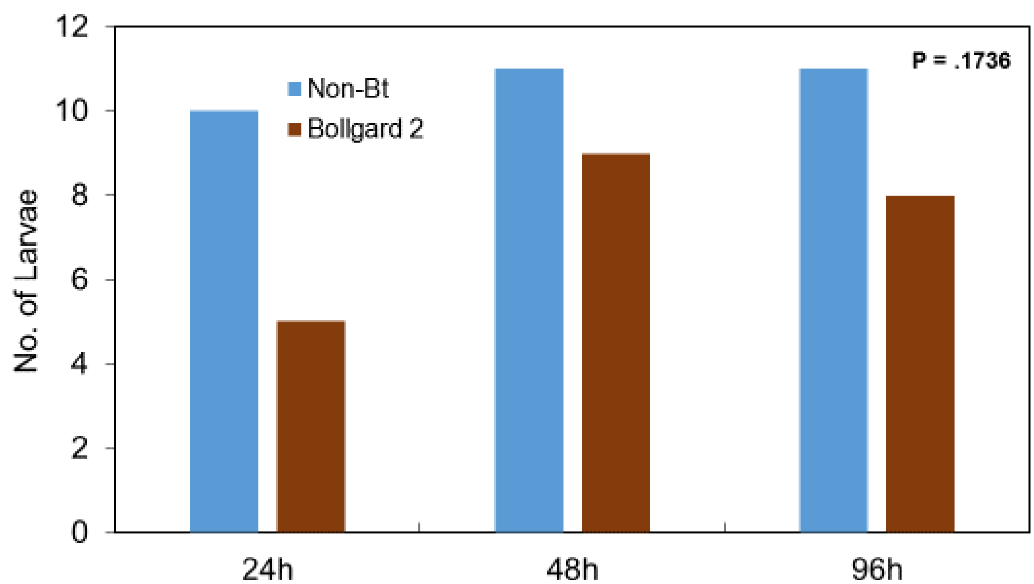

Figure 5. Distribution of larvae on non-Bt and Bt squares.

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