ON-PLANT DISTRIBUTION OF DIAPAUSING PINK BOLLWORM LARVAE

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Abstract

Plant mapping was used to document the on-plant distribution of diapausing pink bollworm larvae by main stem node (MSN) and fruiting position (FP) in late-planted cotton and to estimate numbers of diapausing larvae per acre. Significant numbers of diapausing larvae were recovered on every node and fruit position on the plant, including the first fruiting position of the season (MSN7, FP1). Bolls in first fruiting positions (FP1) accounted for 67.9% (112 of 165) of all diapausing larvae recovered. Overall, 39.6% of all the pink bollworms accounted for (diapausing larvae + exit holes) were in diapause. On average, each plant had 5.5 diapausing larvae and 8.4 boll exit holes, for a total of 13.9 pink bollworm larvae per plant through the season. At 112,340 plants per acre, the 5.5 diapausing larvae per plant translated into 617,870 diapausing larvae *per acre*! This estimate of diapausing larvae appeared to be superior to a different method that used periodic boll samples with interpolation, which estimated 61,380 diapausing larvae per acre.

Introduction

Local information is lacking on the specific diapause behavior of pink bollworm in West Texas. It has been generally assumed that 1) onset of pink bollworm diapause begins "late" in the season, and 2) late season bolls on the tops of the plants are the primary source of overwintering (diapausing) larvae in cotton. However, little in-field data has been collected about the behavior of larvae that would verify or refute these assumptions. The objectives of this study were to use plant mapping sampling methods to determine the on-plant distribution of diapausing pink bollworm larvae in late-planted cotton and to compare estimates of the size of the diapausing population with another method.

Methods

A block of non-*Bt* cotton (HyPerformer HS44) was planted and watered up late (May 29) to promote late season pink bollworm infestation. Row spacing was 38 inches and plant density was approximately 112,340 plants per acre. No insecticides were applied to the block. Neighboring blocks were early planted (April 22) *Bt* varieties that were also untreated. First bloom occurred in the test block on approximately July 24. White blooms were tagged weekly from August 15 through October 26 to link plant development and pink bollworm infestation to calender dates. Plants were left in the field until December to assure that pink bollworm larvae remaining in the lint were in winter diapause and were not reproductive. Thirty plants were randomly selected and brought into the laboratory on December 9 for mapping, which was conducted on December 11. Plant mapping was used to document on-plant locations of fruit and fate of pink bollworm larvae. All fruit were recorded, removed, and placed in bags labeled by main stem node and fruiting position. These fruit were held in a cool room until inspected on January 28 and February 5. Boll inspection included counting exit holes and dissecting lint and seeds for presence of larvae and or pupae (dead or alive). Exit holes and recovered larvae were tallied and recorded by main stem node and fruiting position. All recovered larvae were assumed to be in diapause. It is unknown whether unrecovered larvae that left the bolls (i.e., evidenced by exit holes) were either diapausing or reproductive, but for simplicity were assumed to be reproductive. Seedcotton (lint + seed) was also weighed and recorded by node and fruiting position.

Methods used to estimate diapausing populations were the plant mapping method, and another method using data collected from the same field. For the former, average numbers of diapausing larvae per plant were calculated and then multiplied by plant density (plants per acre). In the latter, estimates of susceptible bolls per acre, larvae per boll, and percent of larvae in diapause were derived from three-week old bolls (tagged at bloom) beginning on August 15 and continuing weekly through September 26.

Results

Plants averaged 10.6 fruiting nodes (first and last fruiting MSNs = 8.1 and 18.7, respectively), and 21.0 total MSNs. The on-plant distribution of harvested bolls is presented in Figure 1, and seedcotton yield is presented in Figure 2. In FP1, MSNs 7-19 showed the highest numbers of fruit retained and highest yield. Main stem nodes above MSN 19 showed a rapid decline in fruit and contribution to yield. The second fruiting position (FP2) contributed most significantly to yield on MSNs 7-18, with FP3 contributing only a small amount on MSNs 9-16.

Figure 3 shows the average on-plant distribution of diapausing larvae and exit holes (i.e, non-diapausing larvae) by MSN, summed over the first three fruiting positions. The sum of diapausing larvae plus exit holes represents the average per-plant infestation. Surprisingly, diapausing larvae were found on all fruiting positions on all main stem

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nodes. Figure 4 shows numbers of diapausing larvae broken down by MSN and FP. Weekly bloom tagging shows average MSNs and FPs by date in Figure 5 (small sample size and inter-plant variation accounts for the crossing of lines between FP1, FP2 and FP3 on 9/12). By these figures, allowing for the majority of boll infestation to occur within 3 weeks post bloom, most bolls from blooms tagged on August 15 (i.e., FP1-MSN $\leq$13, FP2-MSN $\leq$8.7) would have been infested by September 5. Bolls from blooms prior to and including August 15 accounted for 35% of total diapausing larvae recovered. Blooms occurring after August 15, i.e., 3-week-old bolls occurring after September 5 accounted for 65% of total diapausing larvae recovered. Of all pink bollworm accounted for (i.e, diapausing larvae + exit holes), 39.6% were in diapause.

Estimates of diapausing larvae per acre based on the plant mapping method above showed plants in this study to average 5.5 diapausing larvae and 8.4 exit holes, for a total of 13.9 pink bollworm larvae per plant total infestation. At a plant density of 112,340 plants per acre, this translates into 617,870 diapausing larvae per acre! The method used in another study to estimate diapausing larvae utilized regular, periodic samples from tagged blooms to obtain boll density (bolls per acre), larval infestation (larvae per boll), and % larvae in diapause to determine numbers of diapausing larvae per acre per tag date. Values were then interpolated to provide daily estimates through the tagging period, which was hoped to include all diapausing larvae. Blooms were tagged from August 15 on, which as discussed above began on an average of MSN 13 (FP-1) and MSN 8.7 (FP-2). The diapausing population estimate from this method, with interpolation, was only 61,380 / acre. This number does not include the diapausing larvae below MSN 13 (FP-1), which this method missed altogether. Even if larvae from the lower main stem nodes are “dis-allowed” from the plant mapping method, 65% of 617,870 is still 401,616 diapausing larvae per acre, an 85% difference. These findings suggest that the plant mapping method is much more sensitive to detecting diapausing larvae, and it requires much less work and effort.

Discussion

This study confirmed that late season bolls (after September 1) accounted for the majority of diapausing larvae recovered within our test field. However, the study also showed a much higher than expected number of diapausing larvae were generated through the month of August. Because all of the earliest main stem nodes and fruiting positions showed at least some diapausing larvae, additional study needs to be conducted on earlier planted cotton to show the transition period from reproductive forms to diapausing forms in the population. An additional surprise from the sampling was that the majority of the diapausing larvae were found in lint of fully opened bolls and not in the unharvestable “trash” bolls typically associated with late season pink bollworm damage. Because numbers of diapausing larvae generated within a field depends on several factors such as initial PBW pressure, crop maturity, and the availability of hostable bolls, growers need to know how to best impact each of these factors to prevent the buildup of overwintering populations. Manipulation of planting dates, irrigation scheduling, and chemical crop termination each can significantly impact late season attractiveness of fields to pink bollworm moths and the number of offspring they leave behind. Farm practices following harvest may also dramatically reduce the numbers of diapausing larvae that remain, especially the proper disposal (e.g., burial) of trash lint that litters many fields after the strippers or pickers have gone through.

Summary

This study demonstrated very strikingly the large distribution of diapausing pink bollworm larvae on late-planted cotton and the potential for generation of very large numbers of overwintering larvae, even within a “healthy” field. Diapausing larvae were found in otherwise “clean” looking, fluffy white cotton, which suggests that without taking these into account, populations may be significantly underestimated. This information has strong implications toward current management practices, e.g., the need for: 1) early crop termination to reduce buildup of diapausing larvae, and 2) thorough field clean-up of trash lint after harvest. This study demonstrated
that plant mapping can be a potentially useful tool for estimating populations of diapausing (overwintering) larvae in the fall.

Acknowledgments

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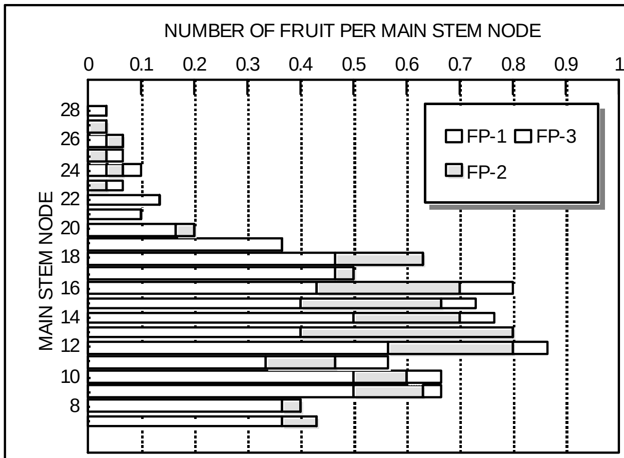

Figure 1. Distribution of Harvested Bolls by Main Stem Node and Fruiting Position

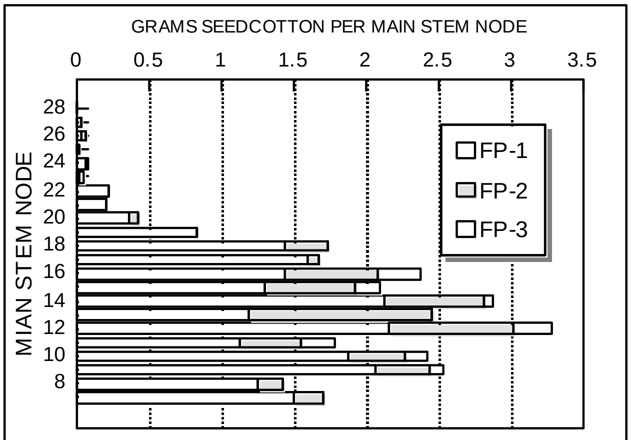

Figure 2. Grams Seedcotton per Main Stem Node

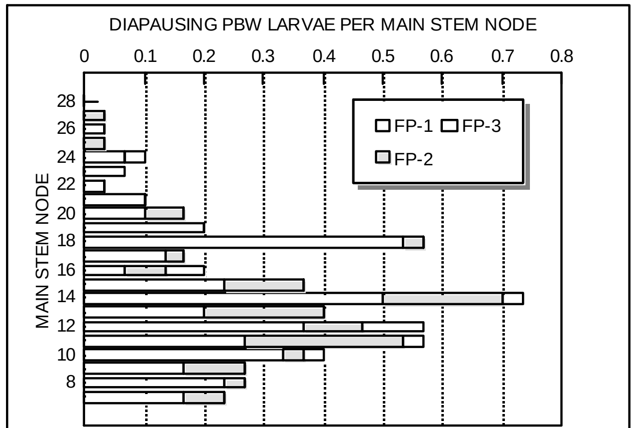

Figure 4. On-plant Distribution of Diapausing PBW Larvae by Main Stem Node and Fruiting Position

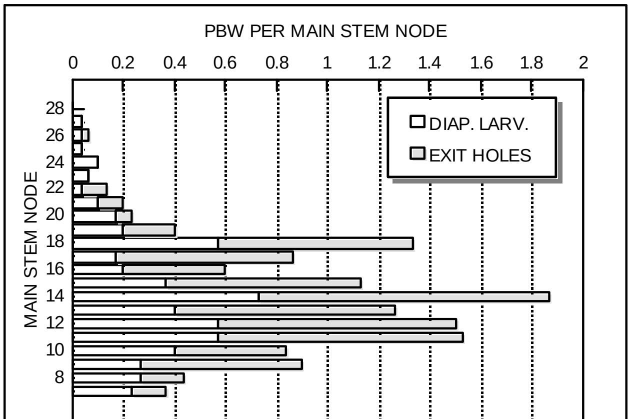

Figure 3. On-plant Distribution and Fate of PBW Larvae by Main Stem Node

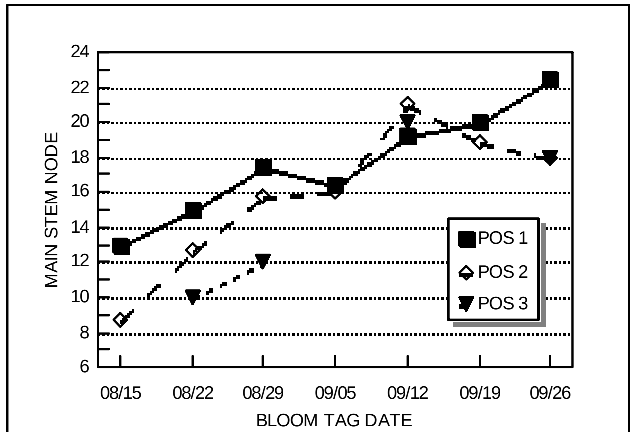

Figure 5. Location of tagged blooms by tag date