EVALUATING TARNISHED PLANT BUG DISTRIBUTION WITHIN COTTON PLANTS POST-INSECTICIDE APPLICATION

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Abstract

The effects of an insecticide application on the distribution of tarnished plant bug (TPB) nymphs within a cotton plant were examined in Louisiana field trials during 2007 and 2008. The location of TPB nymphs was described by vertical sympodial node below the plant terminal, horizontal fruiting position, and specific fruiting form (square, white flower, or boll) in both pre- and post insecticide application samples on insecticide-treated and non-treated cotton plants. Acephate, a standard insecticide recommended for TPB control, was used for the insecticide treatment. The majority of TPB were observed on squares (73% - 94%) compared to white flowers (3% - 18%) and bolls (4% - 15%) pre-treatment and 72 hours after treatment (HAT), respectively, regardless of insecticide treatment. The vertical distribution of nymphs within the upper 10 sympodial nodes was not significantly different between the pre-treatment and 72 HAT samples on non-treated plants. On the insecticide-treated plants, significantly fewer nymphs were observed on fruiting structures in the top five sympodial nodes compared to the number recorded on fruiting structures within sympodial nodes six-ten. The results of this study indicate that TPB nymphs prefer squares and insecticide application does not affect this trend. However, an insecticide application did influence the vertical distribution of TPB nymphs on cotton plants.

Introduction

The tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois), has been a primary pest of cotton across the mid-southern United States, including Louisiana, for the past ten years. In 2007, TPB were ranked as the number one pest infesting >90% of Louisiana's cotton acreage and were responsible for ≈3.6% yield loss (Williams 2008). Heliothines were estimated to cause only a 0.35% yield loss that year. The increase in TPB significance during recent years is related to a reduction in the application frequency of broad spectrum insecticide applications that would have inadvertently controlled TPB populations. The adoption of transgenic *Bacillus thuringiensis* (Bt) cotton cultivars that target heliothines and the success of the boll weevil eradication program have reduced insecticide applications for those pests (Roberts 1999). In addition, there has been an increase in the use of narrow spectrum insecticides that target specific pests. Many of these do not demonstrate satisfactory efficacy against TPB (Leonard 2006).

Several IPM strategies have been recommended to control TPB in cotton. However, chemical control strategies are the primary tool used to manage this pest. Presently, numerous insecticides are recommended for TPB control, but varying levels of resistance has been documented in Mid-South populations to several of these compounds (Snodgrass and Gore 2007). Many of the standard insecticide use strategies can reduce TPB populations, but none have been able to provide consistent and satisfactory control (Leonard 2006, Cook et al. 2007, Leonard and Cook 2008).

Proper timing of the initial and subsequent insecticide sprays is critical to achieve adequate TPB control. Methods for efficiently monitoring insect populations and damage to cotton plants are vital to successfully schedule insecticide applications and assure maximum control. Several indirect and direct sampling methods currently are recommended by Mid-South entomologists to estimate TPB populations and/or damage levels for action thresholds to initiate treatments (Bagwell 2006, Musser et al. 2007). Several factors can affect the accuracy of these sampling methods including: time of day, cotton plant size, growth stage of cotton and insect growth stage (Musser et al. 2007). In addition, insecticide resistance to current products and new insecticide modes of action are influencing the effectiveness of sampling protocols and action thresholds. These issues justify a re-evaluation of TPB sampling protocols and action thresholds. Therefore a team of Mid-South entomologists have coordinated a series of field trials in a regional project to address this need.

To further improve and justify changes in scouting and monitoring protocols for TPB in cotton, a better understanding of TPB behavior and within-plant distribution within cotton plants in needed. Snodgrass (1998) found that on non-treated cotton plants, 75% of the TPB population was located on plant structures within the upper six sympodial nodes. In addition, TPB were more frequently observed on flower buds (squares) than on other plant structures. Most sampling protocols and action thresholds are initially established on non-treated plants and prior to the first insecticide application. In the Mid-South region, multiple insecticide applications are needed to manage TPB during the entire season because cotton fields are frequently re-infested by TPB after insecticide treatments. Sampling protocols and action thresholds should consider the sub-lethal effects of insecticides on migrating populations or on survivors that remain on insecticide-treated plants. Insecticide applications may affect the within-plant distribution of TPB on cotton plants and influence the efficiency of sampling protocols and accuracy of action thresholds. Therefore, the objective of this study is to determine the effects of an insecticide application on the within-plant distribution of TPB on cotton plants during reproductive stages of development. These results should provide insights into the limitations of the current sampling protocols and offer an opportunity to improve the existing recommendations for managing TPB.

Materials and Methods

This study was conducted at the Macon Ridge Research station near Winnsboro, LA. Cotton seed of the cultivars (Delta & Pine Land DP 555 BG RR) were planted during Mid-May of 2007 and 2008. The test areas consisted of field plots (8-16 rows centered on 40 inches) by 300 ft in length. The organophosphate insecticide, acephate (Orthene 90SP, Valent USA Corporation, @ 0.75 lb AI/ acre), and a non-treated control were the two treatments examined in these trials. The insecticide was applied to cotton plants during weeks two – five of flowering. Normal cultural practices and IPM strategies recommended by Louisiana Cooperative Extension Service were used to optimize plant development across the test site. Acephate was applied with a John Deere high clearance sprayer calibrated to deliver 6 GPA with TeeJet TX-6 hollow cone nozzles (two/row). The insecticide was applied to the test areas when native TPB infestations exceeded a mean of one nymph/ row foot from buffer areas surrounding the test area.

The two treatments (insecticide-treated and non-treated) were in placed in a split-plot arrangement within a RCBD and replicated three – five times. Each treatment was divided into sub-plots that were independently sampled pre-treatment and at 24 hours after treatment (HAT), 48 HAT, 72 HAT, 96 HAT, and 120 HAT. Each plot was sampled only due to the need to destructively handle plants as they were searched for TPB nymphs. Three trials were completed in 2007 and two trials in 2008.

To estimate population densities across the test areas, a standard (3 ft x 2.5 ft) black shake sheet was used to sample TPB nymphs. Sampling was accomplished by placing a shake sheet between rows and vigorously shaking adjacent plants to dislodge TPB. Within each plot, cotton plants were randomly selected and searched for the presence of TPB nymphs. Observations were initiated at the plant terminal and progressed down the plant main stem by searching each sympodial branch and fruiting site. In addition, if any fruiting structures were present on vegetative branches located at the bottom of the plant, they were also examined. Individual plant surveys continued within each plot until 20 TPB nymphs had been located. During each sampling period (pre- and post-treatment) the size of TPB nymph and distribution on cotton plants (sympodia and fruiting site) were recorded. Nymphs were classified as large (presence of wing pads, ≥ fourth instars) or small (wing pads not present, ≤ third instars). The within-plant location of TPB was described by main stem sympodial or vegetative node below the plant terminal, horizontal fruiting position on each branch and fruiting form classification (square, white-flower, and boll). Main stem distribution was described by grouping sympodial and vegetative nodes into three vertical strata. The upper stratum consisted of sympodial nodes one-five, the middle stratum consisted of nodes six-ten and the lower stratum consisted of nodes (sympodial and vegetative, if present) eleven-fifteen.

For this report all data were averaged across tests and years of the study. The data was then subjected to PROC MIXED (SAS Institute 2003). When appropriate, significant treatment effects were compared using Tukey's

Studentized Range Test (*P=0.10*). Numbers of TPB nymphs were compared between treatments and among sampling periods, main stem vertical strata, and fruiting structures.

Results and Discussion

During this study, twenty TPB nymphs were found in the non-treated and insecticide-treated plots. However, to find twenty nymphs in insecticide-treated plots, it was necessary to sample at least 40% more plants than in the non-treated plots. On non-treated plants, significantly more TPB nymphs were found on squares (74% - 92%) compared to white flowers (5% - 15%) and bolls (7% - 18%) (Fig. 1). Similarly, insecticide-treated plants also had significantly more TPB nymphs on squares (77% - 86%) compared to white flowers (5% -15%) and bolls (6% - 15%) (Fig. 2). These results are similar to those presented by Snodgrass (1998) and suggest that acephate did not influence TPB nymph preference among fruiting forms. On both insecticide-treated and non-treated cotton plants, the top and middle strata (ten uppermost sympodial nodes) had significantly more TPB nymphs compared to the bottom strata during the pre-treatment and 72 HAT sample periods (Fig. 3). In the study by Snodgrass et al. (1998), the majority of TPB were recorded on plant structures in the upper six sympodial nodes. There were no significant differences in TPB nymphs between the top and middle strata on non-treated plants during the pre-treatment and 72 HAT sample periods. However at 72 HAT, numbers of TPB nymphs in the middle-strata (nodes six – 10) were significantly higher compared to numbers in the upper and lower strata on insecticide-treated plants. These data suggest that an insecticide application can alter main stem vertical distribution of TPB nymphs 72 HAT.

Summary

These results describe the effects of an acephate application on the main stem vertical distribution of TPB nymphs within cotton plants and compare preference among fruiting structures. The distribution of TPB between the upper and middle strata was modified with the insecticide application at 72 HAT. In addition, TPB nymphs were found to prefer cotton squares, regardless of insecticide treatment. This information should be used in conjunction with results from ongoing studies to further refine sampling protocols and action thresholds for TPB on reproductive stage plants in cotton fields

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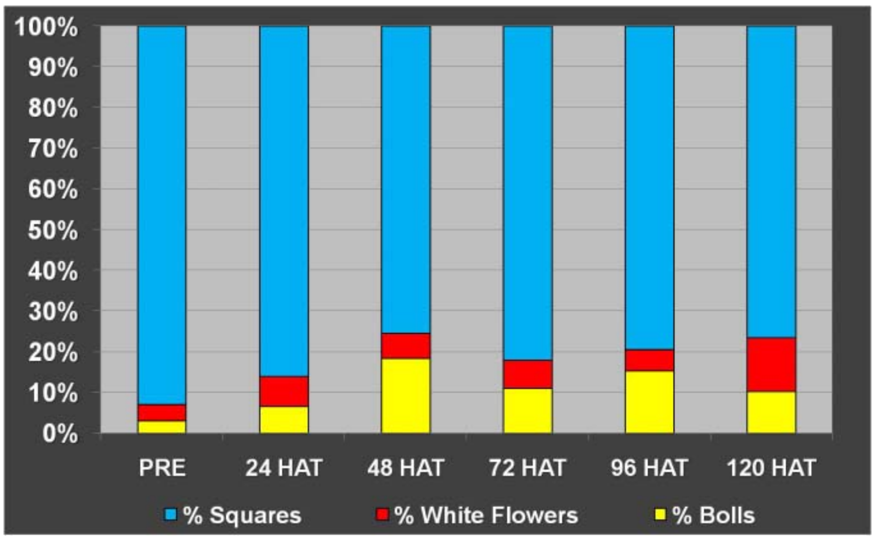

Figure 1. Percent of total TPB nymphs found on fruiting forms among sampling periods on non-treated cotton plants.

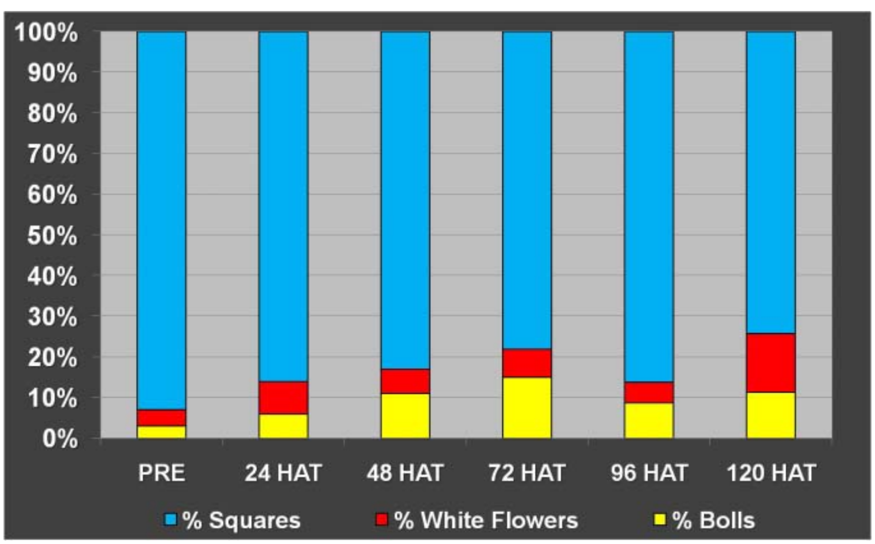

Figure 2. Percent of total TPB nymphs found on fruiting forms among sampling periods on acephate-treated cotton plants.

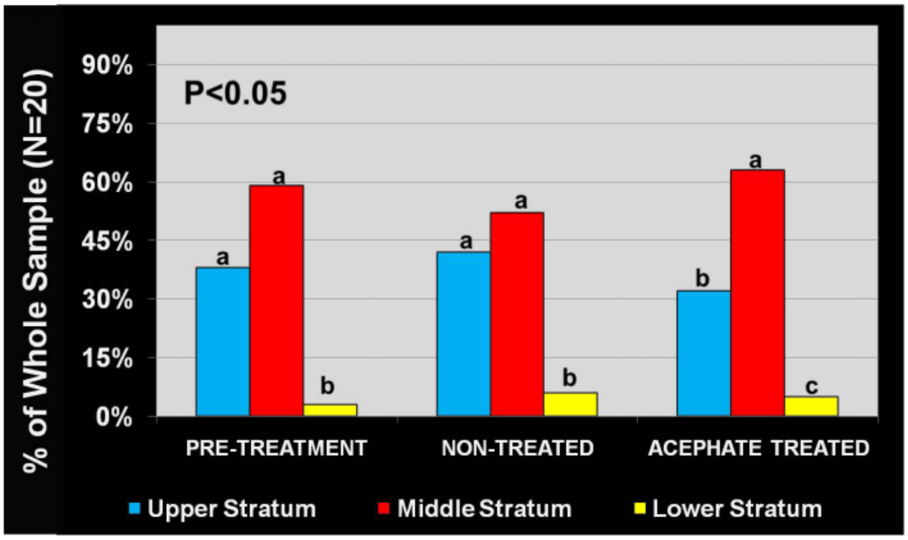

Figure 3. Percent of total TPB nymphs found in three main stem sympodial vertical strata pre-treatment and 72 HAT on treated and non-treated cotton plants.