MANAGING DIFFICULT TO CONTROL TARNISHED PLANT BUGS IN THE MID-SOUTH
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Abstract

Multiple experiments were conducted on cotton in Mississippi to investigate control of insecticide resistant tarnished plant bugs. Experiments that controlled native vegetation during the early spring with a single herbicide application reduced tarnished plant bug numbers in cotton and increased economic returns for growers in the herbicide treated areas. Another experiment demonstrated the benefits of planting an early season cotton variety (Deltapine 444 BR) versus a later season cotton variety (Deltapine 555 BR). Deltapine 444 BR reached cutout approximately one week earlier than Deltapine 555 BR and required two fewer foliar applications with insecticides for tarnished plant bugs. Several insecticide screening studies showed that foliar control with currently registered insecticides ranged from 17 to 71 percent control and control with experimental insecticides ranged from 34 to 57 percent control. In an experiment investigating application intervals, plant bug control approached 100 percent when two applications were made four or five days apart while 70 and 20 percent control was seen when the applications were made six and seven days apart, respectively. Rotation with alternative chemistries was shown to improve control of tarnished plant bugs compared to multiple applications with organophosphates. Plots treated with two applications of Orthene (0.5 lb ai/A) five days apart reached threshold before plots treated with Orthene (0.5 lb ai/A) followed by Centric (2 oz./A). Spray coverage was shown to significantly influence plant bug control. Tarnished plant bug control was higher on okra-leaf cotton than on normal leaf cotton and with hollow cone nozzles than with air induction nozzles. Temik, applied as a side dress at first flower, reduced plant bug numbers for up to 20 days. Based on these experiments, no one method will provide adequate control of resistant tarnished plant bugs in flowering cotton including foliar insecticides. Therefore, growers and consultants will need to consider alternative strategies integrated with foliar applications to prevent economic losses from tarnished plant bugs.

Introduction

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is an important pest of cotton in the mid-South states of Louisiana, Arkansas, Mississippi, and Tennessee. The numbers of insecticide applications targeting plant bugs has been increasing over the past several years. From the mid 1980’s to the early 1990’s, Mississippi growers averaged one or fewer insecticide applications per acre to control tarnished plant bugs; whereas, greater than three applications have been averaged over the last few years (Williams 2006). This increase has been attributed to several factors including boll weevil eradication (Snodgrass and Scott 2003) and Bollgard cotton (Scott et al. 1997). Perhaps more important is the increased levels of resistance to several classes of insecticides. Tarnished plant bug resistance to the pyrethroids was first documented during the early 1990’s (Snodgrass 1996). Efficacy of the pyrethroids against tarnished plant bugs decreased through the 1990’s. Consequently, pyrethroids are no longer recommended for tarnished plant bug control in Mississippi, Louisiana, or Arkansas. More recently, resistance to the organophosphates has been documented in tarnished plant bugs (Snodgrass 2006). Although this class of chemistry remains effective, the standard organophosphates, acephate and dicrotophos, have been less consistent in many areas of the mid-South. Also, higher rates of these insecticides are currently being used compared to what was used ten years ago without the same levels of control. In the past, acephate applied at 0.33 to 0.5 lb ai/A provided good control of tarnished plant bugs. More recently, acephate rates of 0.75 to 1.0 lb ai/A are providing equal or less control than what was obtained with the lower rates in the past. Given the current situation with resistance to the standard insecticides and the lack of newer chemistries to provide comparable control to what was expected with the organophosphates in the past, non-chemical control strategies and novel uses of current insecticides will become
more important. The objective of this paper will be to present results from numerous experiments conducted in the mid-South over the last three years evaluating various management strategies for tarnished plant bugs in cotton.

Materials and Methods

Experiments were conducted at the Jamie Whitten Delta States Research Center in Stoneville, MS during 2004 through 2006. Cotton was planted from late-April to late May depending on the experiment. All standard agronomic practices were followed in each experiment. Additionally, some of the experiments were conducted on commercial farms throughout Mississippi.

Area-wide Plant Bug Management
To determine the impact of spring host plant control on tarnished plant bug populations, experiments were conducted in the Delta region of Mississippi from 1999 through 2004 and the hill region of Mississippi during 2005 and 2006. A single application of a selective broadleaf herbicide (Strike 3® 2,4-D, dicamba, and mecoprop) was applied to all marginal areas of a nine square mile area of crop land in two to four locations. The herbicide application was made from late-February to late March each year. Additionally, two to four adjacent areas of crop land were selected and designated as non-treated. Cotton in each area was sampled throughout the growing season with a standard 15 inch diameter sweep net and numbers of tarnished plant bugs were determined. Insecticide spray records and yields were obtained from all growers within each area and economic analyses were conducted.

Long Season vs. Short Season Cotton Varieties
Management of tarnished plant bugs in a long season variety (Deltapine 555 BR) was compared to management in a short season variety (Deltapine 444 BR). Plots of both cotton varieties were planted on May 9, 2006. Plots were approximately 3 acres in size planted in a randomized complete block design with four replications. Treatments included: 1) early season control, 2) late season control, 3) season long control, and 4) no control. For the early season control, plots were sprayed weekly from pinhead square until first flower. Plots for late season control were sprayed weekly from first flower until cutout. For the season long control, plots were sprayed weekly from pinhead square until cutout. Cutout in these plots were determined based on COTMAN samples taken weekly and was when plots within a treatment averaged nine nodes above white flower plus 350 heat units. Plots were sampled weekly with a 1-m drop cloth and the numbers of plant bug adults and nymphs were recorded.

Foliar Control with Insecticides
Multiple experiments were conducted to investigate tarnished plant bug control with foliar applications of registered and experimental insecticides. In all experiments, plots were sprayed with a John Deere High Clearance sprayer calibrated to deliver 9.5 GPA, 45 psi, and 4.3 mph, except one test with Diamond which was applied with an airplane. For all experiments, plots were sampled at various intervals with a 1-m black drop cloth. Numbers of plant bug nymphs and adults were counted. Summaries of plant bug control with currently registered insecticides and experimental insecticides were developed based on results from multiple experiments. In addition to standard insecticide screening, experiments were conducted to determine optimum spray intervals and effective rotation strategies.

To determine optimum spray intervals, plots of cotton were established that were heavily infested (mean = 23 nymphs per meter) with tarnished plant bugs. The entire test area was oversprayed with Orthene at 0.5 lb ai/A. Numbers of tarnished plant bugs were determined across the test area 4 days after treatment and second applications were made to specific plots with Orthene (0.5 lb ai/A) at various spray intervals. The treatments (intervals) were 4 days, 5 days, 6 days, and 7 days. Plots were sampled every two days with a 1-m drop cloth and numbers of plant bug adults and nymphs were counted. Within the same area, a separate experiment was conducted where various insecticide treatments were applied to plots five days after the first Orthene application. The treatments included Orthene at 0.5 lb ai/A, Orthene at 0.5 lb ai/A plus Diamond at 6 oz./A, Orthene at 1.0 lb ai/A, Centric at 2 oz./A, Trimax at 1.8 oz./A, Carbine at 2.8 oz./A, Vydate at 0.33 lb ai/A, and Bidrin at 0.5 lb ai/A. Plots were sampled every two days with a 1-m drop cloth. When most of the treatments reached threshold (3 bugs per 6 ft) again, a third application was made with Orthene (0.5 lb ai/A) across the entire test area. Plots were sampled 3 days after this application and numbers of plant bugs were recorded.
Spray Coverage and Plant Bug Distribution in Cotton

Experiments were conducted to evaluate the impact of spray coverage on tarnished plant bug control. In the first experiment, plots of normal leaf cotton and okra-leaf cotton were planted in a randomized complete block design with 8 replications. When plant bugs became established in the plots during the flowering stages, treatments were applied. Treatments included Orthene (0.5 lb ai/A) plus Diamond (6 oz/A) and a non-treated control. Treatments were applied with a High Clearance sprayed as described previously. Control in each cotton type was evaluated after 4 days.

In the second experiment, different nozzle types were used to create different levels of spray coverage. The nozzle types included a standard hollow cone nozzle (Teejet TX-12) and an air induction nozzle (Teejet AI 11002). The first test compared control with Orthene (0.5 lb ai/A) between the two nozzle types and a second test compared control with Centric (2 oz/A). In both tests, spray volume, pressure, and speed were maintained at 9.4 gpa, 40 psi, and 5 mph, respectively, for both nozzle types. Approximately one hour after treatment, plant bug adults were caged on treated and non-treated plants to determine percent mortality. For each test, plots were sprayed in a randomized complete block with four replications. Ten bugs were caged in each plot for a total of 40 bugs per treatment. Mortality was determined 48 hours after treatment.

Temik Side-Dress Applications

An experiment was conducted during 2005 to determine the impact of side-dress applications of Temik during the early flowering period on tarnished plant bugs. Plots were planted in a randomized complete block design with four replications. Treatments included Temik (5 lbs/A) applied at first flower, Temik (10 lbs/A) applied at first flower, and a non-treated control. Temik was applied with a modified side-dress applicator. The modification included removal of the coulters that open the furrow and these were replaced with fertilizer knives to minimize root pruning on this larger cotton. The entire tests area was irrigated five days after the application. Plant bug populations were sampled 5, 10, and 20 days after application with a 1-m drop cloth.

Results

Area-wide Plant Bug Management

During the first three years of this program (1999-2001), a single herbicide application in the early spring significantly reduced tarnished plant bug densities in cotton during June and July (Fig. 1). Averaged over three years, plant bug numbers during June and July ranged from 23 to 53 percent lower in the herbicide treated areas than in the non-treated areas. Additionally, the numbers of insecticide applications were lower (Fig 2) and economic benefits were higher (Fig. 3) in the treated areas compared to the non-treated areas. Averaged over the three year period, growers in the treated areas made one less application than those in the non-treated areas. The average economic benefit was $5.90 per acre over the three year period. Similar results can be expected in the hill region of Mississippi base on preliminary data (Fig. 4).
Long Season vs. Short Season Cotton Varieties
Cotton variety had a significant impact on tarnished plant bug densities and control. Overall, tarnished plant bug densities were higher in Deltapine 555 BR than in the earlier maturing Deltapine 444 BR (Fig. 5). Based on COTMAN sampling, Deltapine 444 BR reached cutout approximately one week earlier than Deltapine 555 BR. Consequently, tarnished plant bug populations reached their highest levels during that time and Deltapine 555 BR required two more insecticide applications than Deltapine 444 BR.

Foliar Control with Insecticides
Based on multiple experiments conducted during 2006, tarnished plant bug control ranged from 17 to 71 percent for the currently labeled insecticides (Fig. 6). In general, the organophosphates and neonicotinoids provided similar levels of control; while, the pyrethroids did not provide adequate control. Additionally, testing with four different experimental insecticides showed that they were not as effective as the currently labeled insecticides. Tarnished plant bug control ranged from 34 to 57 percent with these compounds (Fig. 7).
Tarnished plant bug control with Orthene was significantly improved by a second application when the interval between those two applications was no greater than five days (Fig. 8). Tarnished plant bug control averaged 100 percent after the second application when the spray interval was four or five days. In contrast, tarnished plant bug control averaged 70 percent and 20 percent when the spray intervals were 6 days and 7 days, respectively. Also, tarnished plant bug control was better when Centric was included in the spray rotation (Figs 9-12). After the third application, there were fewer tarnished plant bugs in the plots where Centric was included in the rotation compared to all other insecticides (Fig. 11). Plots treated twice with Orthene reached threshold for the third application before plots treated with Orthene followed by Centric (Fig. 12).

Figure 8. Impact of application intervals on tarnished plant bug control with Orthene applied at 0.5 lb ai/A during 2006. The bar labeled “Pre-treatment” shows data for average plant bug densities across the entire test area before any insecticide application. The gray bar shows average plant bug densities across the entire area four days after the first application. The four bars on the right side of the graph show percent control of tarnished plant bugs after the second application of Orthene at the respective spray intervals.
In a test comparing control with Orthene alone to Orthene plus Diamond, plots treated with Orthene plus Diamond had lower plant bug densities and required fewer insecticide applications than plots treated with Orthene alone (Fig. 13). Plots treated with Orthene required four applications; while, those treated with Orthene plus Diamond required three applications.

Figure 13. Impact of Diamond on tarnished plant bug control. The first application was made on July 14, 2005. The arrows show subsequent application dates for the respective treatments.
Spray Coverage and Plant Bug Distribution in Cotton

Spray coverage had a significant impact on tarnished plant bug control. There were more plant bugs in non-treated okra-leaf cotton compared with normal leaf cotton (Fig. 14). However, there were fewer plant bugs in treated okra-leaf cotton than treated normal leaf cotton. Consequently, plant bug control averaged 80 percent in okra-leaf cotton compared to 32 percent in normal leaf cotton with Orthene plus Diamond. Similarly, plant bug control with Orthene and Centric was better when hollow cone nozzles were used compared to air induction nozzles (Figs. 15-16). Tarnished plant bug mortality with Orthene averaged 65 percent and 39 percent with hollow cone nozzles and air induction nozzles, respectively (Fig. 15). Tarnished plant bug mortality with Centric averaged 96.4 percent and 75.8 percent with hollow cone nozzles and air induction nozzles, respectively (Fig. 16).

There were differences in the distribution of tarnished plant bugs on cotton plants treated with Bidrin compared to non-treated plants (Fig. 17). There were more tarnished plant bugs located on nodes 4 through 10 below the terminal than on other parts of the plants. There were more plant bugs on nodes 4 through 10 of non-treated plants (32) than on nodes 4 through 10 of plants treated with Bidrin (14). In contrast, there were more plant bugs below node ten from the terminal on plants treated with Bidrin than on non-treated plants.
Temik Side-Dress Applications

Temik applied as a side-dress at first flower had a significant impact on tarnished plant bug populations (Fig. 18). At 5 days after application, there were no differences in numbers of tarnished plant bugs among the non-treated and Temik treated plants. By 10 days after application, tarnished plant bug numbers were reduced by 60 to 80 percent when Temik was applied at 5 and 10 lbs per acre, respectively. At 20 days after treatment, the Temik still showed activity with plant bug densities being 10 to 31 percent lower than the non-treated plots at the 5 and 10 lb rates, respectively.

Discussion

Based on results of recent tests across the mid-South, many of the insecticides currently available for tarnished plant bug control are not performing as well as they have in the past. Also, there do not appear to be any alternatives in the pipeline that will replace the organophosphates for controlling tarnished plant bugs. Because of the current situation with insecticide resistance in tarnished plant bugs and the lack of alternative chemistries, other strategies will need to be considered to manage tarnished plant bugs. Management of wild host plants that serve as nurseries for plant bugs during the spring and summer will become more important in the future. Destruction of early season hosts has shown promise in reducing plant bug densities over the landscape, thus reducing the impacts to cotton later in the season. Also, as resistance to the organophosphates becomes more widespread, variety selection will be a critical step in crop and pest management. Snodgrass (1996) showed that insecticide resistance in tarnished plant bugs increases throughout the season and the highest levels of resistance are detected in the fall. Therefore, early season varieties should be planted in areas where late season populations are difficult to control. Nectariless varieties should also be considered if they become commercially available in the future.
Despite the reduction in control with the organophosphates, this class of chemistry will remain an important component of integrated pest management programs for tarnished plant bugs. There are several alternatives that should also be considered in rotation with the OP’s. These include the insect growth regulator Diamond, the neonicotinoids, and the newest chemistry Carbine. Current testing has shown that these chemistries rotated with the organophosphates provide better control than the organophosphates alone. Additionally, spray intervals with all classes of insecticides should be shortened to no more than five days.

Spray coverage is another important factor that should be considered. Based on results of the current study, tarnished plant bug control was better on okra-leaf cottons with a more open canopy than on normal leaf cottons. Also, when spray coverage was altered with different nozzle types, control was better with hollow cone nozzles than with air induction nozzles. The pressures used in these experiments were not optimum for spray deposition with the air induction nozzles and these nozzles may provide better control at higher pressures. The purpose of the current experiment was to demonstrate the importance of good spray coverage given the current levels of resistance.

Temik applied as a side-dress can be an effective alternative to foliar applications. However, the rates needed to provide adequate control may be cost prohibitive across whole farms. These applications may be made to small areas where sources of plant bug infestations exist. For instance, treatment of narrow strips of cotton adjacent other hosts or where spray coverage is difficult may provide an economic benefit by limiting movement across entire fields.

In conclusion, no one strategy, including foliar insecticides, will completely eliminate losses from tarnished plant bugs in cotton. Control is likely to become more difficult in the near future as resistance increases and becomes more widespread. Other strategies integrated with foliar insecticides will be critical for management of tarnished plant bugs.

References


