EFFICACY AND YIELD EFFECTS OF DIAMOND INSECTICIDE APPLICATIONS FOR TARNISHED PLANT BUG

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Abstract

Management for the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), in Mississippi has been a challenge for growers in recent years. Research was initiated to evaluate efficacy and yield effects from applications of Diamond® insecticide in cotton. Results from tarnished plant bug (TPB) vial assays indicate 1st instar nymphs were significantly more susceptible to novaluron than 2nd and 5th instars. Laboratory experiments suggested that ingestion of novaluron by adult females significantly reduced the number of eggs laid and the percentage of eggs that hatched. Field trials in this study were used to investigate the value of Diamond insecticide applications during the growing season on both efficacy on TPB nymphs and lint cotton yield. Tank mixed with other insecticides, Diamond significantly improved control of tarnished plant bugs. Also, data suggests that the use of Diamond during the pre-flowering stages of cotton development can improve tarnished plant bug control and significantly increase yields.

Introduction

Tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) has become a major problem for Mississippi cotton producers in recent years. Insecticides have been used extensively to target adults and nymphs. However, tarnished plant bugs particularly in the delta region of the state have become more difficult to control with many of the recommended insecticides. Most of the insecticides that are recommended for tarnished plant bug control are pyrethroids and organophosphates (OP). Researchers have recognized the problem growers are faced with and have been investigating management strategies that will reduce the impacts of this pest. Tarnished plant bugs are known to inhibit a wide range of weed hosts such as horseweed, *Conyza canadensis* (L), and Palmer pigweed, *Ameranthus palmeri* S. Wats. Growers are encouraged to reduce weed hosts on their farms to minimize source populations of TPB that eventually migrate into cotton fields. Insecticide tank mixtures with multiple classes of insecticides are being used to maximize TPB control. Additionally, application intervals have been shortened from 7-10 days to 4-5 days once TPB populations reach the economic threshold. Planting date and cotton maturity experiments have shown a benefit of reducing season long TPB numbers and number of applications with managing cotton for earliness through earlier planting dates and early maturing varieties. Researchers have also investigated the effects of incorporating Diamond insecticide applications into the TPB insecticide arsenal for TPB management.

Diamond (novaluron) is an insect growth regulator that inhibits chitin synthesis in tarnished plant bug nymphs. Diamond will control or suppress plant bugs, stink bugs, cotton flea hoppers, and many lepidopteran pests in cotton. Experiments were initiated at Mississippi State University to evaluate the value of Diamond applications in cotton. Three objectives were addressed with laboratory and field experiments. Objective one was to determine the susceptibility of different tarnished plant bug nymphal stages to Diamond using vial bioassays. Objective two evaluated the impacts of Diamond on tarnished plant bug reproduction. The third objective incorporated Diamond applications in field trials to determine efficacy and yield.

Materials and Methods

Vial bioassays were used to determine LC50 dose-mortality curves for tarnished plant bug nymphs from a USDA laboratory colony in Stoneville, MS. Technical grade novaluron was dissolved in acetone and used to coat the inside of 20 mL glass scintilation vials. First, second, and fifth instar nymphs were tested in the experiment. The doses

used for the first instar nymphs were 0, 1, 2.5, 5, 10, and 15 ug/ vial. Second instars were exposed to 0, 10, 20, 30, and 40 ug/vial. Fifth instar nymphs were exposed to 0, 20, 40, 60, and 80 ug/vial. Thirty nymphs for each dose were placed into individual vials for a total of 3 hours with no food. Nymphs were then removed from the vials and placed into untreated vials with a small piece of green bean as a food source. Mortality was recorded everyday for seven days.

The adult ingestion experiment was initiated to determine the effects of novaluron on tarnished plant bug reproduction. Twenty five newly emerged adult male and female pairs from a laboratory colony in Starkville, Ms were used in the experiment. Treatments for adult tarnished plant bugs were constant exposure (entire trial), weekly exposure (2 times per week), one exposure (exposed for the first two days of the trial), and untreated (clean diet packs for the entire trial). Technical grade novaluron was delivered to the insects through ingestion using artificial diet packs as the source. Treated diet packs had a concentration of 600 ppm novaluron. Number of eggs laid and mortality was recorded three times a week for the entire life of the insects.

Field experiments were applied at 10 gpa (gallons per acre) with TX-6 hollow cone nozzles at 60 psi. Tarnished plant bugs were sampled 4-6 days after treatment (DAT) with a standard 2.5 ft black drop cloth laid between two cotton rows. A sample constituted shaking each row of cotton onto the drop cloth for a total of 5 row ft. Cotton was harvested and lint cotton data was recorded. Data were analyzed using Proc mixed ANOVA at α=0.05.

Results and Discussion

Tarnished plant Bug Bioassays

Results from vial bioassays showed differences in susceptibility among different instar TPB nymphs. First instar nymphs tested had an LC50 of 2.8 ug/vial. First instars were more susceptible to Diamond than 2nd and 5th instars with LC50s of 28.8 ug/vial and 32.4 ug/vial, respectively (Table 1.).

Table 1. Diamond® Vial Assay results for tarnished plant bug nymphs.

Instar	LC50	95% CI
1st	2.8 ug/vial	0.69-4.40
2nd	28.8 ug/vial	21.4-49.5
5th	32.4 ug/vial	17.1-44.1

Impact of Diamond on adult reproduction

Exposure of Diamond insecticide to adult TPB resulted in no differences in the life spans of males and females among the different exposure times. All males and females treated with Diamond lived as long as the untreated control. Number of eggs laid by females treated with Diamond was significantly lower than the number of eggs laid by untreated females. Weekly exposed and constantly exposed females laid 22% and 27% of the total eggs laid by the untreated females. Females treated only once resulted in a significant reduction in egg lay by only 44% of the untreated (Table 2). Percent egg hatch was also affected by the exposure to Diamond. All treatments had significantly lower hatch rates than the untreated control. Constant exposure, weekly exposure, and one exposure by females resulted in 1, 3, and 12% egg hatch, respectively. Untreated females had a 48% egg hatch (Table 2).

Table 2. Results from adult TPB ingestion of Diamond insecticide.

Treatment	Adult life span (d)		Eggs laid/F (% of control)	% Eggs hatched
	M	F		
Constant	13.5 a	14.3 a	19.9 b (22)	1 b
Weekly	15.4 a	15.5 a	25.0 b (27)	3 b
Once	14 a	17.2 a	40.3 b (44)	12 b
Control	15.9 a	16.1 a	91.3 a (100)	48 a

Field Efficacy with Diamond. During 2009

Diamond was applied to half of a commercial field at 9 oz/ac. and the other half was treated Centric at 2 oz/ac. The treatments were applied during the late squaring period when large numbers of adults were migrating into the field, but before the presence of nymphs. Within each half of the field four treatments were super imposed to evaluate the impact on lint cotton yield (Figure 1). All treatments within the Diamond applied section of the field yielded an average of 166.52 lbs of lint cotton more than the Centric applied section. This was a non-replicated trial, so a second experiment was conducted in 2010 with four replications and different application timings to further investigate the impact of early Diamond applications on cotton yield. Figure 2 shows results from applications of Diamond during different growth stages of cotton throughout the season in 2010. Applications of Diamond made during the 3rd week of squaring out yielded other treatments in the trial. The least yield was recorded in the untreated Diamond treatment at 967 lbs lint cotton/ac. These data support the use of Diamond during the late squaring period to maximize tarnished plant bug control and protect yields. Additional applications did not significantly improve yields, but these applications should not be discounted. Additional applications during the flowering stages of cotton development will remain important to help delay resistance to other classes of insecticides.

In field efficacy trials, all treatments significantly reduced TPB nymphs below the untreated check (Figure 3). At 7 DAT2, all treatments still had significantly lower TPB nymphs than the untreated check. However, Bidrin at 6 oz/ac, Acephate at 0.75 lb ai/ac, and Carbine at 1.7 oz/ac did not perform as well as the other treatments in the trial (Figure 4). Both figures 3 and 4 show that Diamond can provide similar levels of control of TPB nymphs as the standard insecticides currently recommended.

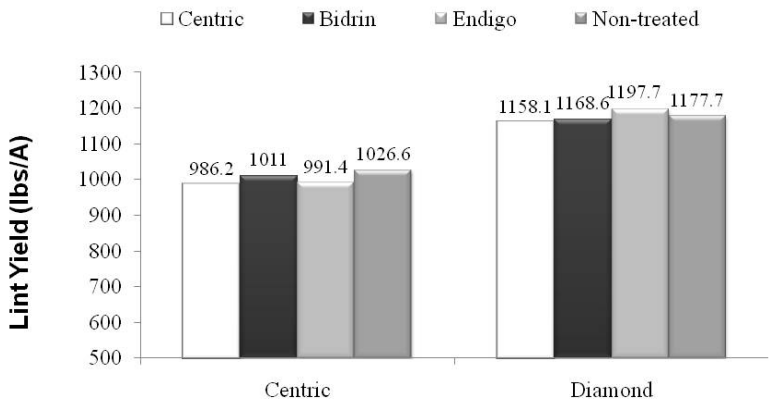

Figure 1. Yield Comparison of 9 oz/ac application of Diamond and 2 oz/ac during the 3rd week of squaring.

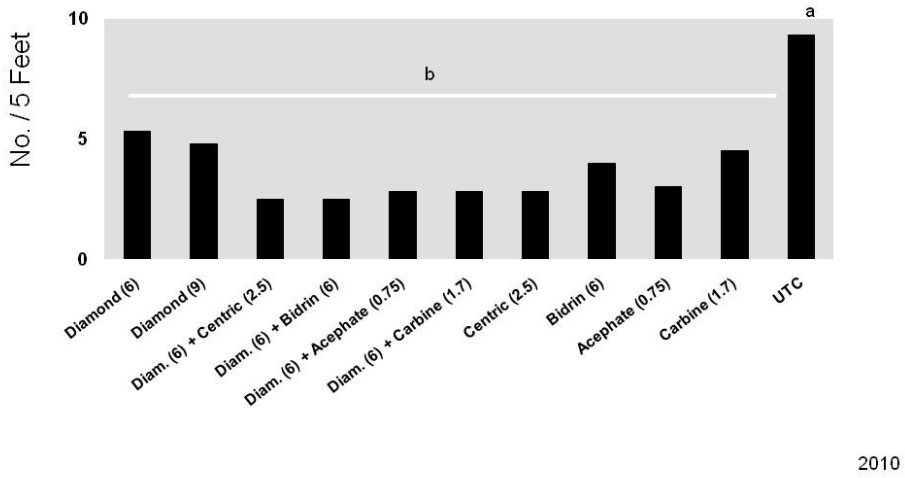

Figure 2. Efficacy of selected insecticides on TPB nymphs 6 days after treatment 1.

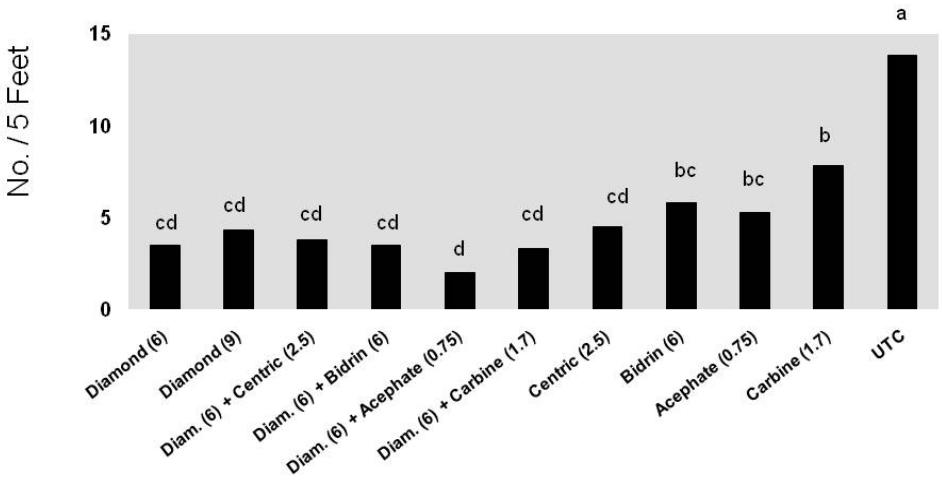

Figure 3. Efficacy of selected insecticides on TPB nymphs 7 days after treatment 2.

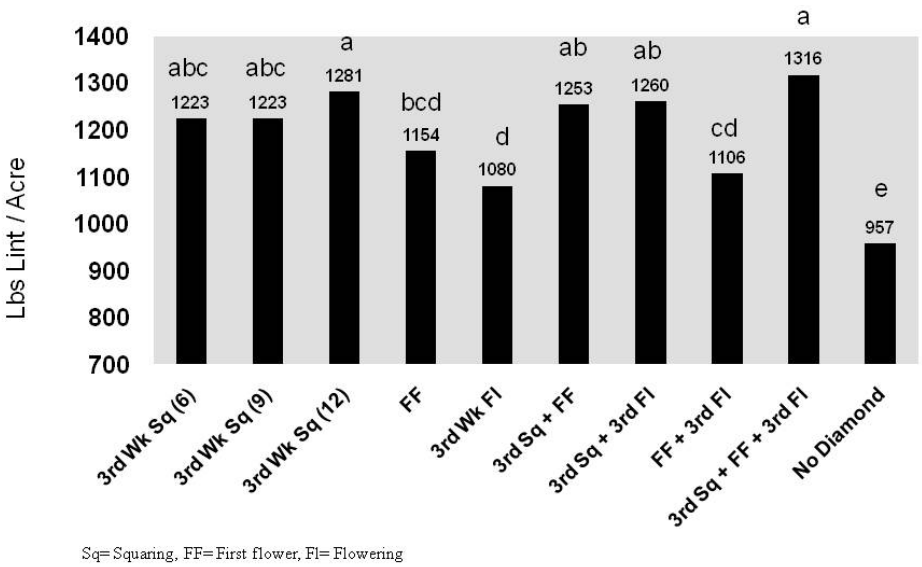

Figure 4. Lint cotton yield from Diamond applications at different physiological stages of cotton.

Summary

Cotton growers in the Mississippi delta continue to battle TPB each year and university researchers realize the impact of these pests directly to cotton yield and input costs. The magnitude of the problem should be met with an extensive evaluation of research agendas to help resolve the problem. Although our reliance on insecticides is heavy, rotating different modes of action and incorporating cultural practices will enhance the longevity of our insecticides. This research is a positive step to help growers combat the TPB. Monitoring our insecticides through assays is a direct way to measure susceptibility of a given population and to detect changes over time. Conclusions from the adult ingestion study also report a benefit of reduced egg lay and hatch rate of female TPB treated with Diamond an insect growth regulator. Insect growth regulators are known to have little to no activity on adult populations. However, the data from this experiment discovered unknown facts about indirect effects on adult TPB. This could expand our options to other products with different modes of action in the future. Efficacy field trials are very important to bridge the gap between the laboratory and the commercial field. This allows growers and researchers to make side by side comparisons among popular insecticides. However, as long as TPB is on the center stage of cotton pest management, research is needed to answer more questions and evaluate current management practices.

Acknowledgements

The authors would like to thank the National Cotton Council ,Cotton Incorporated, and MANA Inc. for the funding of this research.