QUANTIFYING TARNISHED PLANT BUG RESISTANCE TO ACEPHATE IN LOUISIANA COTTON

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Abstract

Acephate is one of the most important control tools of the tarnished plant bug. Tarnished plant bug (TPB), Lygus *lineolaris* (Palisot de Beauvois), resistance to acephate could potentially affect Louisiana cotton production. This study surveyed acephate susceptibility in Louisiana populations of TPB using laboratory assays and evaluated acephate efficacy in field trials. The insecticide residual on glass (vial tests) bioassays were used to determine acephate $LC_{50's}$ for seven populations during 2008. The LC_{50}'s for these collections ranged from 9.54 to 32.36 µg/vial. The resistance ratios (RR) calculated for all populations ranged from 3.1-10.44 and indicated that field control failures with acephate were likely if infestations were high. The field efficacy tests included five treatments (0[control], and acephate at 0.54, 0.82, 1.1, and 1.34 kg AI/ha) that were arranged in a Latin square design and placed in commercial production fields. A positive rate response for acephate was not observed, and at only one site did the highest rate produce > 80% control. Control of TPB was sporadic with acephate and suggests resistance is playing a role in managing this pest.

Introduction

The tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois) is an economic pest of cotton across much of the Southern U.S. (Snodgrass 1994). Prior to boll weevil, *Anthonomus grandis grandis* Boheman, eradication and the introduction of Bt-cotton cultivars, the TPB historically was considered a secondary pest of cotton. Elimination of the boll weevil and essentially the tobacco budworm, *Heliothis virescens* (F.) with these pest management tools has allowed the TPB to emerge as a primary pest of cotton in many areas of the mid-South.

During the period 1990-2007, the cost of TBP control has generally increased in Louisiana. Consequently, there has been an associated increase in reliance on acephate and dicrotophos as control tools for TPB. These two insecticides are the most frequently used products for TPB (Snodgrass and Gore 2007). This increased reliance on acephate and dicrotophos has created considerable concerns that insecticide-resistant TPB populations could rapidly develop across Louisiana.

Circumstantial evidence suggests acephate resistance could already be impacting cotton production. In 1996, the LSU AgCenter recommended use rates of acephate for control of the TPB at 0.33 to 0.54 kg AI/ha (Bagwell et al. 1996). During 2008, acephate is being applied at ≈2X higher use rates (0.54 to 1.1 kg AI/ha) against TPB (Bagwell et al. 2008). In addition, numerous control problems have been reported, even when using multiple applications at the highest labeled rate of 1.1kg AI/ha. Survey by Snodgrass (2006) documented changes in Mississippi TPB susceptibility to acephate for several years. The first TPB populations demonstrating significant resistance to acephate were found in the Mississippi delta region during 2005 (Snodgrass 2006). Annual surveys have continued to show a decrease in acephate susceptibility, but more populations are developing resistance levels that may lead to field control problems (Snodgrass 2007). The objectives of this research were to determine the range of acephate susceptibility for Louisiana populations of TPB and evaluate the efficacy of acephate at selected use rates for performance against TPB.

Materials and Methods

Populations of TPB were collected from various locations and hosts throughout the Louisiana's cotton production areas using a standard (15 inches) sweep net during April–August, 2008. TPB were collected from nine (Vidalia (2X), Newellton (2X), Crowville, Start, Wisner, ULM, and Newlight) locations across the state. The primary main hosts included narrow leaf vetch, *Erigeron spp.,* crimson clover, *Rumex spp.*, horseweed, and *Amaranthus spp.* The TPB were aspirated from the sweep net, placed into a plastic box, and fed washed green beans, *Phaseolus vulgaris.* Samples of all TPB populations were delivered to the USDA-ARS Stoneville, MS, where the glass vial bioassay procedures developed by Dr. Snodgrass (1996b) were performed. The results of these tests were subjected to SAS probit regression to establish LC_{50}'s and 95% confidence limits.

Once field efficacy tests were established TPB were collected from wild hosts located adjacent to the field tests. The LC_{50} of these populations collected near the test area were compared to percent control of the field efficacy test in order to observe if there were any correlation between the results of the two experiments.

Nine field trials evaluating acephate (Acephate 97SP) efficacy were performed in commercial production fields of cotton across Louisiana. Acephate was evaluated at 0.54, 0.82, 1.1 and 1.34 kg AI/ha with a control treatment at all sites. All treatments were arranged in a Latin square (5x5) design. Plot size was four rows by 50 feet long. Treatments were applied with a CO_2 back pack sprayer calibrated to deliver 12 GPA at 30 psi with Teejet 110015VS nozzles (2/row). Treatment efficacy was evaluated five to seven days after treatment (DAT) using a 2.5 ft black drop cloth. The middle two rows of each plot were sampled twice with the drop cloth for a total of 10 row feet being sampled. Percent control was calculated for each treatment.

Results and Discussion

The acephate resistance surveys revealed all TPB populations exhibited significant resistance levels to acephate (Table 1). The populations at the Vidalia and Newellton locations were sampled twice (April and May). The LC_{50}'s for these collections ranged from 9.54 to 32.36 µg/vial. The Vidalia (2) and Start populations exhibited the highest LC_{50}'s of 28.25 µg/vial and 32.36 µg/vial, respectively. These values were significantly different from the LC_{50}'s of all other populations based upon the non-overlap of 95% confidence limits.

Table 1. Survey of acephate susceptibility in Louisiana populations of tarnished plant bug, 2008.

Location	Date	n	LC_{50}	95% CL	Slope	RR	X^2
Vidalia	April 28	210	14.22	(11.56-16.96)	1.074	4.6	0.4041
Newellton	April 28	210	18.97	(16.03-22.43)	1.1174	5.2	0.1904
Crowville	April 28	210	16.58	(14.24-19.11)	1.410	5.34	0.4443
Vidalia	May 16	270	28.247	(24.04-33.81)	1.028	9.11	0.1696
Newellton	May 16	210	19.96	(16.74-23.84)	1.106	6.44	0.9997
Start	May 16	210	32.360	(26.85-41.95)	1.093	10.44	0.673
*Wisner	July 31	180	10.54	(8.74-12.26)	1.484	3.40	0.5665
*Newlight	Aug 8	150	9.54	(7.77-11.20)	1.445	3.08	--
*Monroe	Aug 8	180	16.13	(13.23-19.67)	1.054	5.20	0.1463

Reference susceptible population from Crossett, AR LC_{50} = 3.1 µg/vial. Population used to calculate RR.
*Wisner, Newlight, and Monroe populations collected from areas adjacent to field efficacy tests.

The calculated resistance ratios (RR) of each TPB population were compared to the results of an acephate-susceptible (reference) colony established by Snodgrass (2006). This reference colony was collected from Crossett, AR., where there is no commercial row crops acreage. Any population with an RR > 3 ($LC_{50\ field}/LC_{50crossett}$) could result in a control failure. The RR's calculated for all 2008 populations were >3 and ranged from 3.1-10.44. Unsatisfactory control with acephate was likely if field infestations were sufficiently high (Table 1, Fig. 1).

Figure 1. Acephate resistance ratios (RR) for Louisiana populations of tarnished plant bug, 2008.
Reference population: LC50 = 3.1 µg/vial from Crossett, AR.
Any population above the RR line has ≥3-fold resistance and should be difficult to control in the field.
The Wisner, Newlight, and Monroe samples were collected from areas adjacent to field efficacy tests.

The average percent control of TPB at each rate (across all test sites) of acephate during 2007 and 2008 is presented in Figure 2. The highest labeled rate (1.34 kg AI/ha) used the in 2007 and 2008 tests provided 81% and 54% control, respectively. A reduction of >25% in TPB control was recorded from 2007-2008 in Louisiana. A significant rate response (0.54 to 1.34 kg AI/ha) for acephate was not observed at any one site or across all sites, and at only one site did the highest rate produce >80% control.

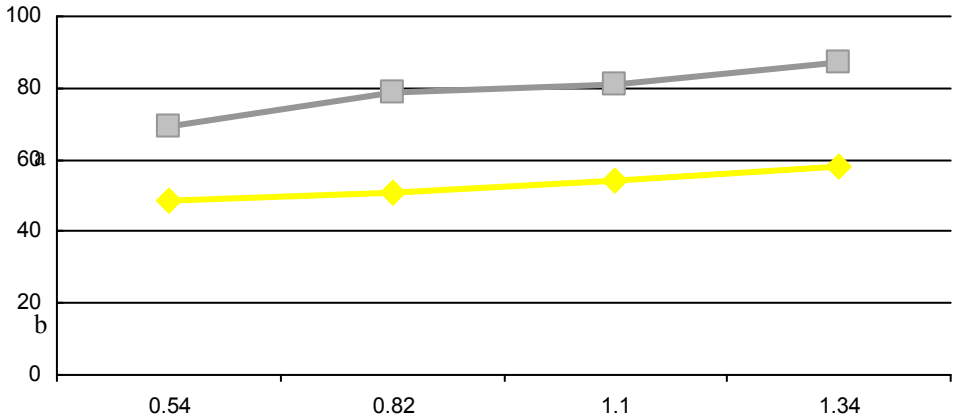

Figure 2. Field efficacy (% control) with Acephate 97 at selected rates (kg AI/ha) against tarnished plant bug across all test sites during 2007 and 2008; a = 2007, b = 2008.

Summary

The results of the dose response bioassays and field efficacy experiments indicate that resistance is partially responsible for TPB control failures with acephate. The rates of acephate (.82 to 1.1 kg AI/ha) recommended for use in Louisiana during 2008 provided ≈50% control. Additional testing will be performed in Louisiana during 2009, but Louisiana cotton producers should exercise caution when using acephate to control TPB, especially in the presence of high and persistent infestations. Alternative insecticides such as Centric, Endigo, Bidrin, and Carbine should be used for TPB control whenever possible.

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