TOXICITY AND EFFICACY OF GLUFOSINATE ON TWOSPOTTED SPIDER MITE IN COTTON

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Abstract

Susceptibility of twospotted spider mite (TSSM), *Tetranychus urticae* (Koch), to foliar applications of glufosinate ammonium (Liberty 280 SL) were evaluated on Liberty Link cotton. Liberty applied at 43 fl-oz/acre provided mite control equivalent to a standard acaricide application of fenpyroximate (Portal) at 16 fl-oz/acre. However, under droughty conditions, significant phytotoxicity was observed and application cost for 43 fl-oz of Liberty is substantially greater than the equally efficacious application of Portal. Applications of Liberty at 10 and 22 fl-oz/acre provided unsatisfactory control of spider mites. Leaf dip bioassays suggest that Liberty is toxic to spider mites with an LC_{50} of 6 ppm. Due to the high cost associated with Liberty, it is not considered a viable treatment targeting spider mites but may prove useful for controlling mites when utilized for weed management.

Introduction

The TSSM status as an economic pest in Midsouth cotton has changed over the last 10 years. Numerous factors such as the use of neonicotinoid based insecticide seed treatments, use of broad-spectrum insecticides for control of other economically important pests, and inadequate or poor fall and spring vegetation management may have contributed to the increase in spider mites becoming a season long pest in Midsouth cotton production systems. With spider mite control options solely relying on limited modes of action, alternative management strategies warrant investigation. One such strategy is the use of Liberty herbicide for pre and post-plant control of broadleaf and grass weeds in glufosinate tolerant crops. In previous years, anecdotal accounts from agricultural producers and crop advisors reported the acute toxicity of glufosinate to TSSM in agricultural settings. Also, (J.F.S.,unpublished data) documented the efficacy of glufosinate on TSSM populations on cotton in Mississippi. Therefore, we investigated the acaricidal activity of Liberty to TSSM in field grown cotton and determined the susceptibility of TSSM to Liberty through the use of a leaf dip bioassay.

Materials and Methods

Foliar Design

All studies were performed at the Macon Ridge Research Station (MRRS, LSU AgCenter) near Winnsboro, LA (Franklin Parish) during the 2015 growing season. The cotton variety used was Stoneville 5289 GLT (Glytol Liberty Link) and was planted on 29 May. All plots consisted of four rows (centered on 40 inches) by 50 feet in length. Treatments were arranged in a randomized complete block design with four replications.

Foliar Treatments

Foliar treatments were applied using a 3 liter, 2 row hand boom calibrated to deliver 10 GPA at 3 mph with Teejet TX-6 hollow cone nozzles(2/row).Treatments consisted of Liberty herbicide applied at 10, 22, and 43 fl-oz and the standard acaricide control consisted of 16 fl-oz of Portal applied on 13 Aug.

Foliar Sampling

Ten fully expanded leaves were pulled from the top 3 nodes 0, 5 and 14 days after application. Samples were placed in paper bags and transported to the lab for processing. Whole leaves were processed using a mite brushing machine (Fig. 1), and adults and immatures were counted using a dissecting microscope and pooled for analysis.

Figure 2. Mite brushing machine used for all mite life stage removal

Leaf Dip Bioassay

Research was conducted at LSU AgCenter's MRRS in 2015. Seven concentrations of formulated Liberty herbicide (0, 1, 5, 10, 15, 20 and 25 ppm) were obtained from serial dilutions and each concentration was replicated 8 times. Fifty six healthy, arthropod free cotton leaves were collected from Stoneville 5289 reared in the green house at MRRS for leaf dip assays. Collected leaves were washed with tap water and placed abaxial side up and allowed to air dry for 1 hour. Once all moisture was dried from leaves, 8 leaves were assigned to each treatment. Leaves were fully submerged in each concentration for 5 seconds, placed abaxial side up and allowed to air dry until all moisture has dissipated. A 2.54 centimeter punch was used to extract 8 leaf cores for each treatment. Individual leaf cores were placed in petri dishes filled with 15 ml of agarose gel. After the cores were placed on the gel surface, 10 female, field collected adult TSSM were placed on each core and each Petri dish was capped and paraffin applied to seal all gaps. Sealed Petri dishes were placed in a growth chamber set to 27 ºC with 75 % RH and 14/10 L:D setting. Spider mite mortality was assessed 48 hours after infestation. Mites were examined under a dissecting microscope and considered dead when mites failed to respond to prodding with a fine paint brush.

Data analysis

Foliar data were subjected to ANOVA and means were separated using an F protected LSD ($P < 0.05$). Bioassay data were subjected to non-linear regression analysis and Poloplus Probit analysis with 95% confidence intervals (CI) obtained for the TSSM population.

Results and Discussion

Foliar Control

Spider mite populations built up to damaging levels in 2015. Liberty applied at 10 and 22 fl-oz/acre gave unsatisfactory control of TSSM in this study. At 5 DAA, the 10 and 22 fl-oz rates of Liberty were not significantly different and provided less than 50% control of TSSM (Fig. 2a-c). At 14 DAA, the 10 fl-oz rate provided virtually no control of TSSM and was not significantly different than the non-treated check. Conversely, Liberty applied at 43 fl-oz provided satisfactory control 5 and 14 DAA and was not found to be significantly different from the positive control treatment of Portal. At 14 DAA, both the high rate of Liberty and Portal still provided greater than 50% control of TSSM populations (Fig. 2a).

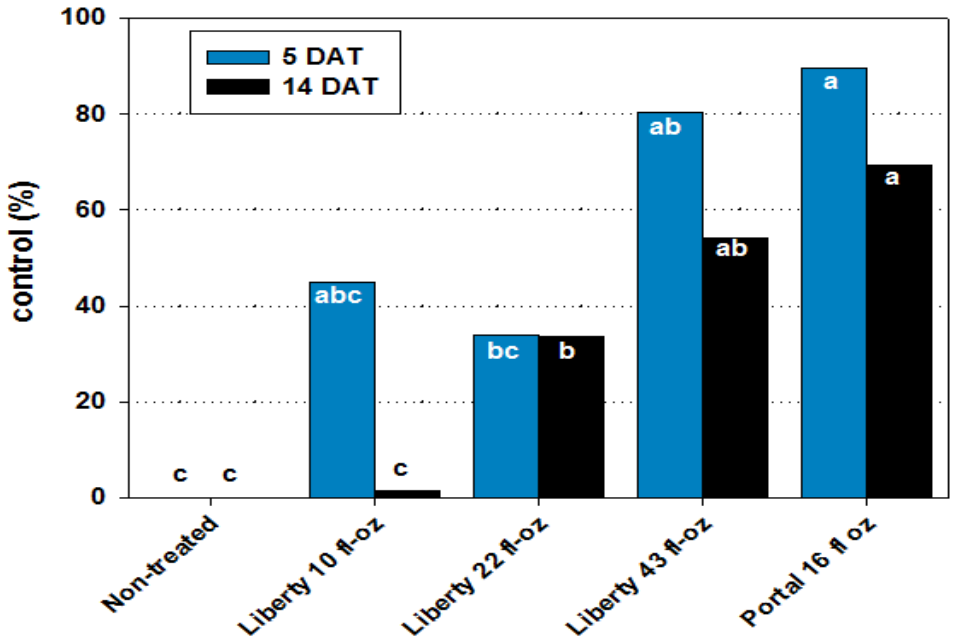

Figure 2a. Percent control (Henderson-Tilton) of foliar applications of Liberty to TSSM in cotton.

Phytotoxic Effects

Significant phytotoxic effects were observed at the conclusion of this study (Fig. 3). Liberty applied at 10 and 22 fl-oz caused between 15 and 25% chlorosis and necrosis (Fig. 2b) of treated plots. No significant differences in phytotoxicty were detected between the 10 and 22 fl-oz rates. Liberty applied at 43 fl-oz caused significantly more phytotoxicity than any other treatment with 50% of treated plots experiencing substantial chlorotic and necrotic injury (Fig. 2b). Portal and the non-treated check exhibited almost no phytotoxic (< 5%) symptoms resulting in no significant differences between treatments. Visible symptoms did not appear until after the study was concluded.

Figure 3. Phytotoxic effects of Liberty to drought stressed cotton. (Left) cotton treated with 10 fl-oz of Liberty, (Right) cotton treated with 43 fl-oz of Liberty.

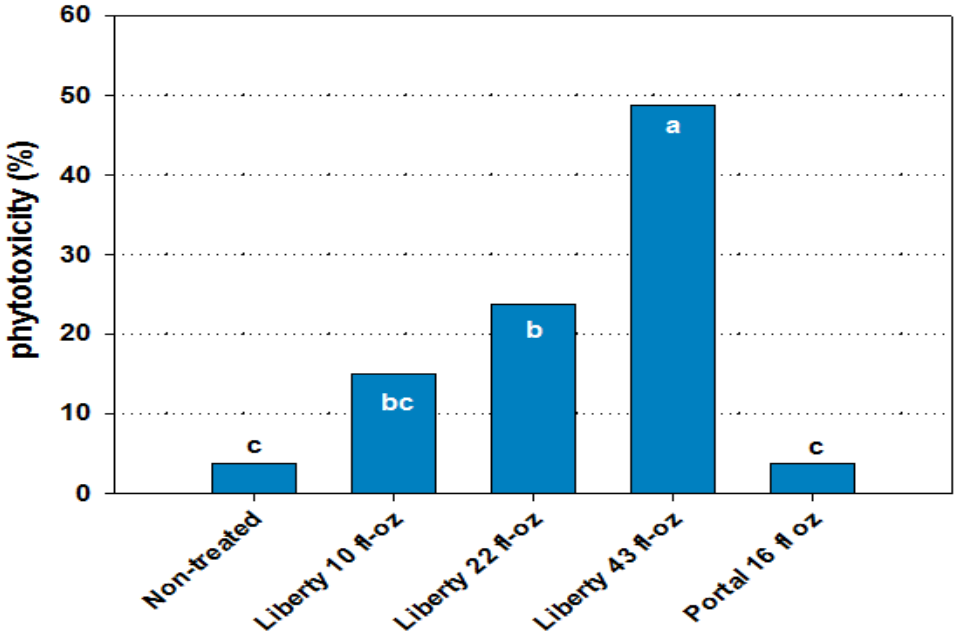

Figure 2b. Phytotoxicity ratings of foliar applications.

Bioassay

Leaf dip bioassay results indicated that TSSM were highly susceptible to concentrations of Liberty. The LC_{50} value was determined to be 6.27 ppm with 95% CI determined to be (1.98 – 11.77) (Fig.2c). Non-linear regression analysis indicated a significant (P <0.0001) dose mortality relationship (R^2 = 0.51).

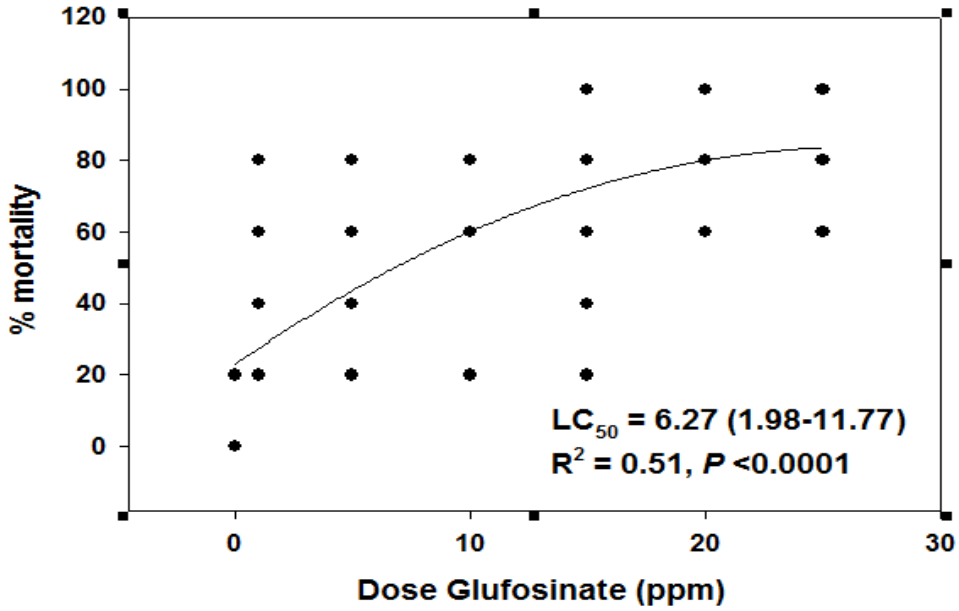

Figure 2c. Dose response curve of TSSM to glufosinate.

Discussion

The use of Liberty herbicide, on damaging populations of TSSM, provided control comparable to a standard acaricide when used at the maximum label rate. Dose mortality bioassays indicated that TSSM were highly susceptible to

Liberty herbicide and appropriate field use rates may provide an added acaricidal benefit to pre-plant weed management or use throughout post crop emergence weed control. However, use of Liberty at the stage conducted in this experiment would be considered an off-label application. Liberty requires a 70 day pre-harvest interval (PHI) which allows for foliar applications to made in the early squaring to first bloom period. Furthermore, the high cost associated with the use of Liberty is not considered a viable treatment targeting spider mites. Dedicated acaricides such as Portal are significantly less expensive, have shorter PHI's and cause very little phytotoxicity when used appropriately. The cotton utilized for this test was experiencing severe drought stress, coupled with advanced maturity resulted in the abnormal levels of phytotoxicty experienced. However, these results are analogous with (J.F.S., unpublished data) that Liberty herbicide may provide added benefits to producers outside of weed control. The use of Liberty, as resistance management tool, for glyphosate resistant weeds such as palmer amaranth (*Amaranthus palmeri*) coupled with the acaricidal benefits demonstrated in this study, may give producers an effective option in controlling weeds as well as populations of spider mites in cotton