EFFICACY OF APHICIDES ON COTTON APHIDS, *APHIS GOSSYPII*, AND THEIR NATURAL ENEMIES J. Lindsay D. Kerns S. Brown S. Williams LSU AgCenter Winnsboro, LA

Abstract

The cotton aphid, *Aphis gossypii*, has the potential to cause detrimental losses to a cotton crop. The use of chemical control is the most common choice of farmers to eliminate not only the cotton aphid but many other arthropod pests as well. Some commonly used insecticides may only worsen an aphid outbreak by removing aphid predator species and allowing an aphid population to dramatically increase. The objective of this study was to observe the mortality effects of various insecticides on the larvae of the ladybeetle, *Hippodamia convergens*, a natural enemy to the cotton aphid. Carbine, Centric, Intruder, and Transform were used in an assay study at standard label rates. Each insecticide was tested indirectly vs. directly on the ladybeetle larvae. The efficacy of Centric, Intruder, Transform, and Cruiser on the cotton aphid, as well as their effects on the natural enemy population, was examined in a field study. Significant differences were observed between the various spray treatments and the numbers of beneficial insects.

Introduction

The cotton aphid, *Aphis gossypii*, has been recognized as a major pest of cotton since when Dwight Isely (1946) reported that insecticide applications used to control the boll weevil would cause populations of cotton aphids to increase dramatically. These high populations would cause stunted growth and development of the cotton plant along with the growth of black sooty mold associated with the honeydew secretions of the aphid. These effects still occur today with heavy aphid infestations. These infestations can occur naturally or are commonly due to insecticide application that dramatically decreases natural enemy populations allowing aphid numbers to increase.

Aphids can be found feeding on the abaxial surface of cotton leaves and on the terminal area of the plant. Nutrients in the form of phloem sap are extracted from the plant using sucking/piercing mouthparts and excess sugars are excreted as honeydew. Loss of cellular fluid causes downward cupping of leaves which is a major indicator of cotton aphid damage. Prolonged feeding can cause premature leaf abscission and even induce defoliation (Isley, 1946, Leigh et al. 1996). A number of other results can be observed due to injury including shorter plants, reduced shoot biomass, and fewer main stem nodes (Bagwell and Baldwin 2005, Rosenheim et al. 1997).

Biological factors allow this insect's population to rapidly grow, as well as, rapidly adapt resistances to insecticides. Recommendations for controlling aphid populations include careful insecticide selection and usage along with conservation of natural enemy species. The purpose of this study is to evaluate relationships among seed treatments, foliar spray insecticide treatments, cotton aphid populations, and its natural enemy species populations. These data can be utilized in current and future control of the cotton aphid. This study will also provide a more complete ecological view of the natural enemy species populations before, during, and after control measures against the cotton aphid have been taken.

Methods

Field Test

The field tests were performed at Macon Ridge Research Station in Winnsboro, LA. The test was a 2x4 factorial and contained four replicates in a randomized complete block design. The plots were eight rows and measured 8.1 m wide \times 15.2 m in length. Factor A of the test was a seed treatment and factor B was the foliar spray insecticides. The seed treatment Cruiser 5FS (thiamethoxam) at 0.375 mg-ai/seed was applied prior to the planting date of 23 May 2013. The foliar spray insecticide treatments were applied on 21 June 2013. The foliar spray treatments were

applied using a four-row multi boom with two nozzles per row. The spray system was pressurized with CO_2 and calibrated to deliver 93.5 liters/ha with TX-6 hollow cone nozzles.

The aphid population was estimated by randomly selecting ten leaves from rows two and three of each plot. The beneficial insect species were counted using the drop cloth method (1.5 row-m) in rows six and seven of each plot. Pre-treatment data was collected on 21 June 2013, just prior to application. Data was again collected three and five days after treatment. The data were analyzed using a factorial ANOVA and means were separated using a pairwise t-test ($P \le 0.05$).

Bioassays

Lady beetle larvae bioassays were performed using third/fourth instar *Hippodamia convergens* larvae collected from cotton. Thiamethoxam (Centric), sulfoxaflor (Transform), acetamiprid (Intruder), and flonicamid (Carbine) treatments were evaluated for toxicity to lady beetles at rates of 0.43, 0.14, 0.10 and 0.32 kg-ai/ha, respectively.

Three bioassays were performed for each insecticide treatment: direct exposure, indirect exposure, and ingestion of intoxicated aphids. For each bioassay, non-treated 25-mm diameter cotton leaf discs were cut and placed in petri dishes filled with agar. The treatments were applied using a CO_2 pressurized two row hand boom with TX-6 hollow cone nozzles that was calibrated to deliver 93.5 liters/ha. For the direct exposure bioassay a single lady beetle larva was placed on each leaf disc prior to treating. For the indirect exposure bioassay, the leaves were allowed to dry before the introduction of a single lady beetle larva to each leaf disc. Leaf discs treated for the ingestion bioassay were allowed to dry and then infested with 10 adult cotton aphids. These aphids were allowed to feed for 24 h after which a single lady beetle larva was introduced. The petri dishes for all assays were stacked on trays that were then placed in a growth chamber set to 25° C on a 12:12 L:D. Lady beetle mortality was rated 24 h after introduction for all bioassays. Data were analyzed using a one-way ANOVA, Kruskal-Wallis test, and a pairwise comparison was made using a Dunn's multiple comparison test (P < 0.05).

Results and Discussion

Field Test

Significant differences were observed after treatment in aphid population, as well as, natural enemy population. Lady beetle adults and larvae comprised 45% of the natural enemies that were observed. There was a significant interaction between the seed treatments and the foliar sprays in for cotton aphids per leaf (P = 0.023) (Figure 1). Cotton with the seed treatment alone or in combination with a foliar spray had few aphids (Figure 1), few lady beetle larvae (Figure 2) or total predators (Figure 3). Thus, thiamethoxam (Cruiser), exhibited adequate control of cotton aphids and this lack of aphids resulted in few predators inhabiting those plots. The foliar spray treatments of sulfoxaflor (Transform) and acetamiprid (Intruder) both exhibited excellent control of cotton aphids at 5 DAT, while thiamethoxam (Centric) exhibited only moderate control (Figure 1). The lack of greater activity form thiamethoxam towards cotton aphids was not unexpected since resistance to this insecticide is common in the Mid-South (Gore et al. 2013. The non-treated plots had significantly more lady beetle larvae at 5 DAT (Figure 2). Among the foliar insecticides, sulfoxaflor had the most surviving lady beetle larvae although not statistically more than the thiamethoxam and acetamiprid treated plots. All of the foliar sprays contained a similar number of total predators (Figure 3).



Figure 1. Impact of thiamethoxam seed treatment and foliar insecticide sprays on cotton aphids in cotton.



Figure 2. Impact of thiamethoxam seed treatment and foliar insecticide sprays on lady beetle larvae in cotton.



Figure 3. Impact of thiamethoxam seed treatment and foliar insecticide sprays on insect predators in cotton.

Bioassays

Significant differences were only observed in the direct exposure bioassay (Figures 4-6). Acetamiprid exhibited the most detrimental effects, while thiamethoxam and sulfoxaflor were moderately toxic to the lady beetle larvae (Figure 4). There were no significant differences observed between flonicamid and the non-treated check. No significant differences were observed in the indirect exposure and ingestion assays. The indirect contact assay results suggest that all treatments were safe to the larvae once dried on the leaf. Even though the ingestion assay results exhibited no significant differences between the treatments, factors such as the amount of aphid feeding time allowed before the addition of the larvae and the number of aphids provided to each larva could have affected the results. These factors will be adjusted in future studies.



Figure 4. Direct exposure bioassays of lady beetle larvae exposure to foliar insecticides.



Figure 5. Indirect exposure bioassays of lady beetle larvae exposure to foliar insecticides.



Figure 6. Ingestion bioassays of lady beetle larvae fed insecticides intoxicated cotton aphids.

References

Bagwell, R. D., and J. L. Baldwin. Louisiana. 2005. LSU AgCenter Research and Extension. Aphids on Cotton. http://www.lsuagcenter.com/NR/rdonlyres/8FA471A6-FEE1-4150-9825-30C2CA84425E/11536/pub2455aphids2.pdf.

Gore, J., D. Cook, A. Catchot, B. R. Leonard, S. D. Stewart, G. Lorenz and D. Kerns. 2013. Cotton Aphid (Heteroptera: Aphididae) susceptibility to commercial and experimental insecticides in the Southern United States. J. Econ. Entom. 106:1430-1439.

Isley, D. 1946. The cotton aphid. Ark. Exp. Sta. Bul. 462.

Leigh, T. F., S. H. Roach and T. F. Watson. 1996. Biology and ecology of important insect and mite pests of cotton. *In* Cotton Insects and Mites: Characterization and Management, E. G. King, J. R. Phillips and R. J. Coleman, eds. Cotton Foundation Reference Book Series. 3rd ed. Memphis, TZ.

Rosenheim, J. A., Wilhoit, L. R., Goodell, P. B., Grafton-Cardwell, E. E. and Leigh, T. F. 1997. Plant compensation, natural biological control, and herbivory by *Aphis gossypii* on pre-reproductive cotton: the anatomy of a non-pest. Entom. Exp. et App, 85: 45–63.