NATURAL ENEMIES AND POPULATION DYNAMICS OF THE COTTON APHID, *Aphis gossypii,* IN GEORGIA

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Abstract

The cotton aphid has become a consistent and abundant pest of cotton in Georgia, but the extent of economic damage inflicted by this pest is unclear. This study was undertaken to evaluate the impact of natural enemies on cotton aphid populations, and to assess the impact of aphids on cotton yields. Four treatments were evaluated: (1) an untreated control, (2) a benomyl (fungicide) treatment to reduce the activity of the entomopathogenic fungus Neozygites fresenii, (3) an imidacloprid treatment when aphids were present on >50% of the plants, and (4) an imidacloprid treatment when aphids were present on >>50% of the plants, and natural enemies were present. The studies were conducted in a commercial cotton field with 1-acre plots and four replicates of each treatment (total of 16 acres). Cotton aphid populations were low until late June, when numbers increased, triggering imidacloprid treatments in early July. Aphid populations declined rapidly in the imidacloprid plots, but declined nearly as rapidly in all other plots as a fungal epizootic decimated the aphid populations. Other natural enemies appeared to have less impact, although a few other natural enemy species were found in the field (e.g., Scymnus spp. and other coccinellids). Seed cotton yields were higher in fungicide treated plots, but no significant differences were observed among any of the remaining plots.

Introduction

The cotton aphid, *Aphis gossypii,* is a frequent pest throughout much of the U.S. cotton belt and is considered a major pest in many cotton producing states (Hardee *et. al*., 1994). Despite the abundance of this insect and its pest status, questions remain about the real economic impacts of cotton aphids on cotton. Reduced lint quality due to honeydew accumulation on open bolls is well documented, but yield and quality reductions as a direct result of aphid feeding prior to boll opening have not been clearly demonstrated, particularly in the southeastern United States. Effective management of cotton aphids requires an understanding of the negative effects of varying levels of the pest, as well as an awareness of the impact of natural enemies on aphid populations. Conservation of natural enemies in cotton in Georgia has been greatly facilitated in recent years by the success of the boll weevil eradication program and the introduction of Bt-transgenic cotton. Reduced insecticide use for control of the boll weevil and the bollworm complex has created opportunities to incorporate natural enemies into IPM programs for a number of cotton pests including the cotton aphid. Aphid natural enemies are often abundant in cotton, but their potential for suppressing aphid populations is poorly understood (Kerns and Gaylor 1993).

In this study, we tracked populations of cotton aphids and their natural enemies throughout the growing season, measured the effects of aphid populations and aphid management schemes on yield, and evaluated the role of natural enemies in suppressing aphid populations. Our objectives for the study were to evaluate the effect of natural enemies on cotton aphid populations and to assess the impact of aphid infestations and management on yield.

Experimental Design

The study was conducted in a commercial field planted in Bt-transgenic cotton (DPL 33b), with 4 treatments replicated 4 times (16 plots total, 1 acre each; CRB design). Treatments were: 1) An untreated control; 2) Fungicide (chlorothalonil) treatment to reduce activity of the entomopathogenic fungus *Neozygites fresenii;* 3) Current practice: Imidacloprid treatment when aphids were present on >50% of the plants; 4) Enemies threshold: Imidacloprid treatment when aphids were present on >50% of plants using natural enemy rules.

The fourth treatment applied natural enemy rules to insecticide use. The rules were dynamic, in that they varied by relative abundance of select natural enemies. These rules were such that insecticide was to be applied when: 15 aphids/leaf if no fungus, parasitoids, or predators; OR 30 aphids/leaf if no fungus, 10% aphids mummified, 0.3 coccinellids adults/row foot, 0.2 coccinellid larvae/row foot; OR 50 aphids/leaf if 10%visible fungus, no predators or parasitoids; OR 70 aphids/leaf if 10% visible fungus, 10% mummified aphids, 0.3 coccinellid adults/row foot, 0.2 coccinellid larvae/row foot. In practice, the "Enemies threshold" was never applied as none of the pre-defined conditions were met during the study. Thus, the "natural enemy rules" treatment was equivalent to the untreated control.

To assess the efficacy of natural enemies, four types of exclusion cages (no cage, open cage, partial exclusion cage, and total exclusion cage) were placed in each plot. Three cages of each type were placed on individual fruiting

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branches in each plot (with 10-30 aphids each). Cages were examined three times weekly to count aphids and natural enemies. Cages were monitored in two periods: 30 June to 12 July, and 15 July to 9 August. Aphid populations in each treatment were assessed by counting aphids on the first fully-expanded terminal leaf and a mature middle leaf of 20 randomly selected plants per plot. Natural enemies were counted using a 1-meter shake cloth, sampling 24 row feet in each plot. Open field samples and yield were analyzed using a one way analysis of variance (ANOVA).

Results and Discussion

Aphid Populations

Aphid populations were quite variable during the season, but rose steadily after late June, peaking in the first 2 weeks of July (Table 1). Aphid populations declined rapidly thereafter.

Aphid numbers were significantly lower in the current practice treatments following application of Imidacloprid on July 5th and remained significantly lower for the remainder of the growing season. No significant differences in aphid numbers were observed between any of the remaining treatments, none of which were treated with insecticide. The application of fungicide had no significant impact on aphid populations.

Aphid populations crashed in mid July in all treatments, presumably due to an epizootic caused by the entomopathogenic fungus *Neozygites fresenii* (analysis pending). After the populations peaked in July, and rapidly declined, aphids persisted at low to moderate levels in the various plots.

Yield

Seed cotton yield was significantly higher in fungicide treatments (Table 2), although the basis for this difference is unknown. No significant differences in yield were observed among any of the remaining treatments. There were no significant differences among treatments for fiber length, but there were significant differences in micronaire and in strength (Table 3). These differences did not produce clear trends, however.

Cage Treatments and Predator Populations

Aphid numbers varied among cage and field treatments, but there were no clear patterns of increased aphid density in relation to cage type. In the fungicide treatment, aphid numbers in the total and partial exclusion cages were significantly higher during the peak period (2-9 July), suggesting that arthropod natural enemies did have an impact in this treatment. In the other treatments, however, cage type had either no significant effect, or there was no clear pattern. Overall, arthropod natural enemies had a limited impact in our study. However, as noted above, aphid populations in all treatments were suppressed after the population peak by the activity of the fungus *Neozygites fresenii*.

Predator populations were very low throughout the year, perhaps due to drought. Populations did increase in mid-July but peaked at much lower levels than have been historically observed during this same period. These low numbers may have yielded atypical results for the impact of arthropod natural enemies.

Conclusions

Aphid natural enemies have the potential to regulate aphid populations in production cotton fields, but the most important natural enemy was *Neozygites fresenii.* Arthropod natural enemies did not appear to have a major impact in this study. The Imidacloprid treatment was effective at reducing aphid numbers, but the reduction in aphids had no significant effect on yield, nor did aphid numbers have any consistent effect on cotton quality. This would suggest that in Georgia, aphids may have minimal impact on the cotton crop, even when high populations are attained. Arthropod natural enemy populations were very low during the study, probably due to the severe drought conditions encountered in the region. Under more normal growing conditions these natural enemies may play a more substantial role in suppressing cotton aphids. Despite the severity of the drought, the fungus *N. fresenii* appeared to be highly efficacious.

References

Hardee, D.D., Weathersbee, A.A.III, Smith, M.T. 1994. Biological control of the cotton aphid. Proceedings Beltwide Cotton Conferences. 132-133.

Kerns, D.L., and Gaylor, M.J. 1993. Biotic control of cotton aphids (Homoptera, Aphididae) in cotton influenced by two insecticides. Journal of Economic Entomology. 84:1824-1834.

Table 1. Mean aphid population numbers in response to treatment and date (1999 growing season). Populations are given as the mean number of aphids present on a terminal and middle leaf from 80 plants per treatment.

	Date				
Treatment	**6/23**	**6/30**	**7/8**	**7/20**	**8/3**
Untreated	9.2	70.9	167.2	7.96	7.85
Fungicide	4.8	68.8	174.9	8.73	6.70
Standard Treatment	3.0	67.1	25.11	12.01	4.81
Enemy threshold*	1.9	42.9	179.1	8.55	4.33

*The enemy threshold treatment was treated in the same manner as the untreated control.

Table 2. Seed cotton yield by treatment (kg/ha). Mean yields followed by the same letter are not significantly different.

Treatment	Yield (kg/ha)
Untreated	2685.2 A
Fungicide	3227.7 B
Standard treatment	2712.3 A
Enemy threshold*	2603.8 A

*The Enemy threshold treatment was treated in the same manner as the untreated controls.

Table 3. Quality of cotton in response to treatments for cotton aphids. Means in columns followed by the same letter are not significantly different (Waller Duncan Bayesian *k* ratio, *k* =100).

Treatment	Length	Strength	Micronaire
Untreated	1.06 A	27.23 AB	4.60 A
Fungicide	1.08 A	28.40 A	4.50 AB
Standard treatment	1.04 A	26.65 B	4.08 AB
Enemy threshold*	1.08 A	26.63 B	4.05 B

*The enemy threshold treatment was treated in the same manner as the untreated controls.