INCLUSION OF BENEFICIAL INSECTS INTO THE COTTON APHID TREATMENT THRESHOLD

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RESEARCH PROBLEM

Aphids are a serious insect pest in Arkansas and more information is needed on control and threshold treatment levels. The objective of this study was to design management methods which incorporate the action of biological control agents in establishing a threshold for the cotton aphid, *Aphis gossypii*.

BACKGROUND INFORMATION

The primary means of managing the cotton aphid is through application of insecticides based on treatment thresholds that fail to take into account the pest's natural enemies. Currently, treatment thresholds in Arkansas rely only on the percentage of infested plants when aphid populations are increasing. This study incorporates the use of beneficial insects and the entomopathogenic aphid fungus, *Neozygites fresenii*, into the decision-making process. The use of natural enemies in making treatment decisions is a new and novel concept in row-crop agriculture.

METHODS

The 12-acre Clarkedale, Arkansas, study field was subdivided into 16 plots, each ~ 0.75 acre in size (56 rows x 63 m). The experiment consisted of four treatments with four replicates in a Latin Square design: (1) untreated control, (2) fungicide treated, (3) conventional threshold, and (4) experimental threshold. The fungicide treatment was used in an attempt to disrupt the action of the aphid fungus (Wells et al., 2000). Conventional plots were treated when >50% of the plants were infested and aphid populations were increasing (Johnson, 2001). Experimental plots were treated when the conventional threshold was reached *and* aphid densities exceeded 15 aphids/leaf IF "no"

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fungus, parasitoids or coccinellids; 30 aphids/leaf IF "no" fungus, 10% mummies, 1 coccinellid adult/row-m, 0.6 coccinellid larvae/row-m; 50 aphids/leaf IF 10% visible fungus, no parasitoids, or coccinellids; or 70 aphids/leaf IF 10% visible fungus, 10% mummies, 1 coccinellid adult/row-m, 0.6 coccinellid larvae/row-m.

Twice-weekly samples of aphid number and types (small, large, winged, and parasitized) were taken from one fully-expanded terminal and one middle leaf from 20 randomly selected plants in each plot. Additionally, five aphid-infested terminal leaves and five aphid-infested middle leaves per plot were collected and placed in marked vials of 70% ethanol to analyze for the presence and percent infestation of the fungus *Neozygites fresenii* (Steinkraus et al., 1991).

Twice weekly samples of natural enemies were taken using a dislodgement method where the plants were struck onto a wire covering a wash basin (Elkassabany et al., 1996). Density levels of beneficial insects were obtained by sampling 8 row-m per plot (8 samples per plot each sample 1 row-m in length). Beneficial insects collected using this method included: the coccinellids (lady beetles) *Coccinella septempunctata*, *Harmonia axyridis*, *Hippodamia convergens*, *Coleomegilla maculata*, *Scymnus* spp., predaceous Heteroptera *(Geocoris* spp., *Orius insidious*, *Nabis* spp.), lacewings *(Chrysopa* spp., *Hemerobius* spp.), and others (spiders and *Collops quadrimaculatus*).

RESULTS

Cotton aphid populations began increasing in mid-June to mid-July until reaching the conventional treatment level on 18 and 28 June 1999 (Fig. 1), 28 June and 3 July 2000 (Fig. 2), and 7 and 12 July 2001 (Fig. 3). The experimental treatment threshold was reached on 28 June 1999, 3 July 2000, and 19 July 2001. An application of 0.22 L/ha of imidacloprid was made to appropriate plots when aphids reached the threshold levels. When aphid populations neared a peak after the final insecticide applications, an epizootic of the fungus *Neozygites fresenii* caused a rapid decrease in aphid numbers. The aphid peak occurred on 29 Jun 1999 (Fig. 1), 6 July 2000 (Fig. 2), and 27 July 2001 (Fig. 3).

Aphid densities declined over the three years of the study; in the untreated plots, aphids/leaf peaked at ~140 in 1999 (Fig. 1), ~40 in 2000 (Fig. 2), and ~13 in 2001 (Fig. 3). Similarly in treated plots, aphids/leaf increased to ~50 in 1999 (Fig. 1), ~40 in 2000 (Fig. 2), and ~15 in 2001(Fig. 3).

The coccinellids (adult and larvae) were the dominant aphid predators present in the cotton field each year (Fig. 4). The larval density curve followed the aphid density increase with a lag of 5 to 10 days. Larval coccinellids/row-m in the untreated plots peaked at ~9 in 1999 (Fig. 5), ~4 in 2000 (Fig. 6), and ~0.6 in 2001 (Fig. 7). Larvae/row-m in the treated plots peaked at ~3 in 1999, ~1.5 in 2000, and ~ 0.5 in 2001. The adult coccinellid growth curve followed the increase in the larval curve with a lag of 5 to 10 days. Adult coccinellids/row-m in the untreated plots peaked at ~3 in 1999 (Fig. 5), ~2.5

in 2000 (Fig. 6), and ~0.5 in 2001 (Fig. 7). Adult coccinellids/row-m in treated plots peaked at ~1 in 1999, ~2 in 2000, and ~0.5 in 2001. In 2001, malathion sprays for the boll weevil eradication program that occurred on 5 and15 June and on 3, 11, 18, and 24 July clearly affected natural enemy populations (Fig. 7).

In 1999, cotton lint yield was significantly higher in plots using the experimental threshold ($P<0.05$, LSD) in comparison to untreated plots (Fig 8). Yields using conventional threshold were intermediate and not significantly different from untreated or the experimental plots. In 2001, cotton lint yield was higher than in 1999 or 2000.

PRACTICAL APPLICATION

The experimental threshold resulted in a 1 to 2 week delay in treatment application in each of the three years. The treatment delay eliminated the need for a second application in the experimental plots. We feel that the presence of the coccinellids permitted the treatment delay. The cotton lint yields were not negatively affected by reduced insecticide application during any of the three years. In fact during 1999 when aphid populations were greatest, there was a significant increase in yields in the experimental plots.

Research results indicate that inclusion of beneficial insects into the economic threshold have the potential of delaying the initial insecticide application and reducing the number of insecticide applications. Such delays in application oppose conventional wisdom, but show a potential for maintaining yields and decreasing the likelihood of pesticide resistance in the cotton aphid. This new and novel approach promises a benefit to cotton production, and on-farm demonstrations are planned for the 2002 growing season.

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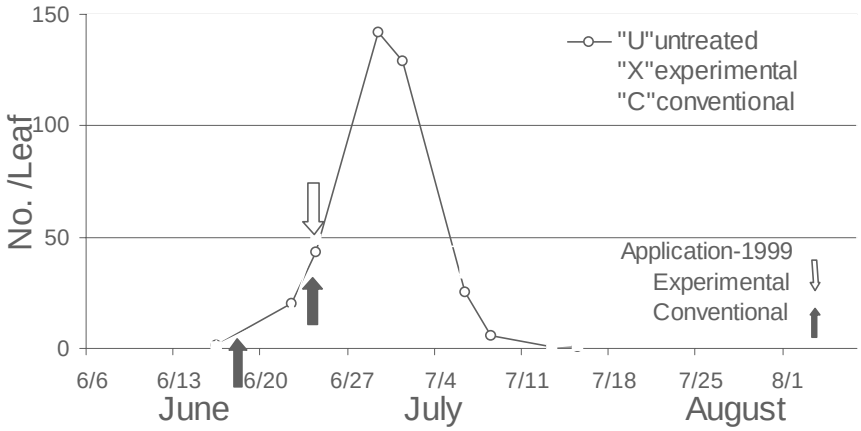

Fig. 1. Aphids per leaf from test plots at Delta Branch Station, Clarkedale, AR, 1999.

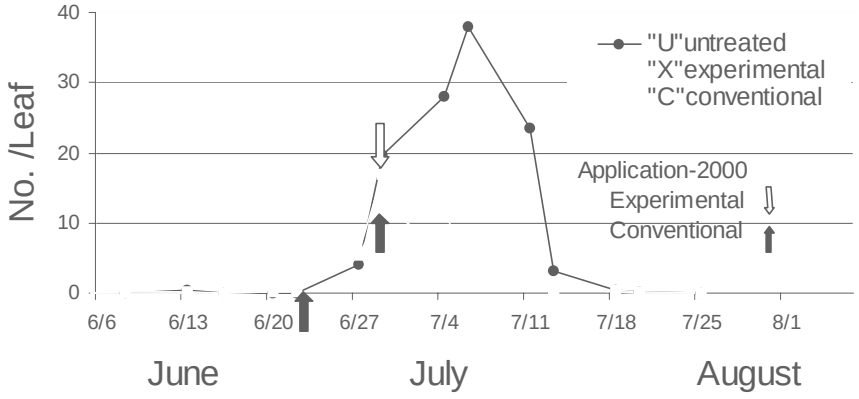

Fig. 2. Aphids per leaf from test plots at Delta Branch Station, Clarkedale, AR, 2000.

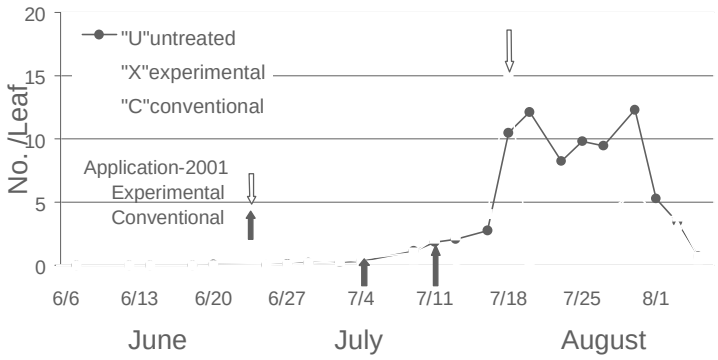

Fig. 3. Aphids per leaf from test plots at Delta Branch Station, Clarkedale, AR, 2001.

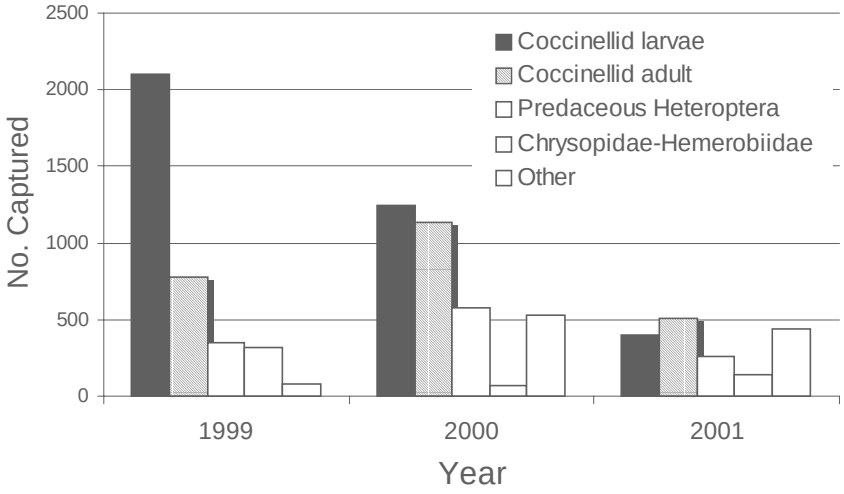

Fig. 4. Comparison of beneficial insects per year from test plots in Delta Research Station, Clarkedale, AR, 1999-2001.

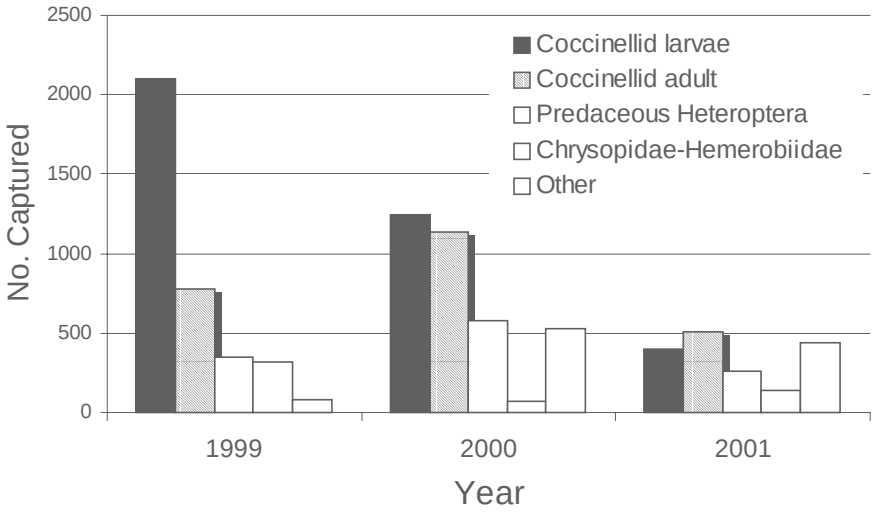

Fig. 5. Coccinellid (adult and larvae) per row meter taken from test plots in Delta Research Station, Clarkedale, AR, 1999.

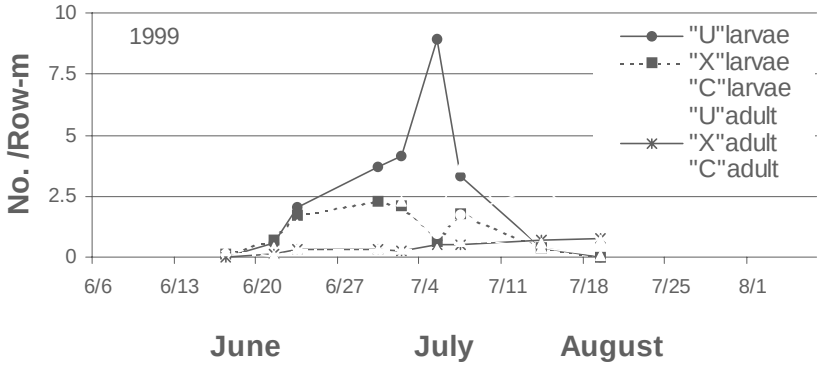

Fig. 6. Coccinellid (adult and larvae) per row meter taken from test plots in Delta Research Station, Clarkedale, AR, 2000.

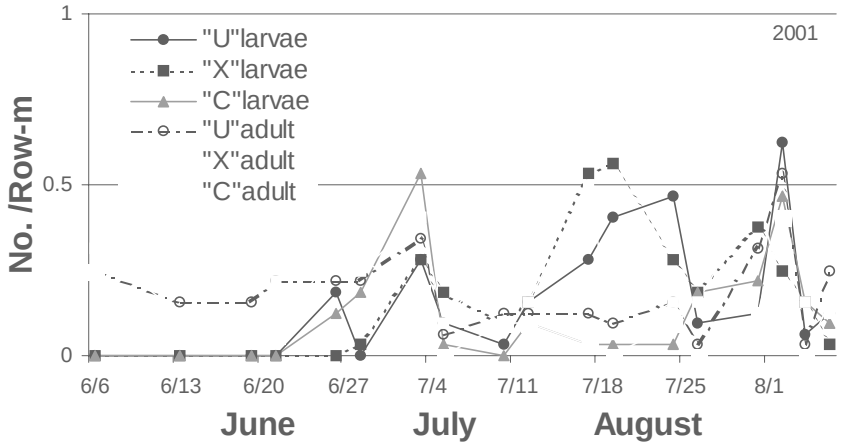

Fig. 7. Coccinellid (adult and larvae) per row meter taken from test plots in Delta Research Station, Clarkedale, AR, 2001.

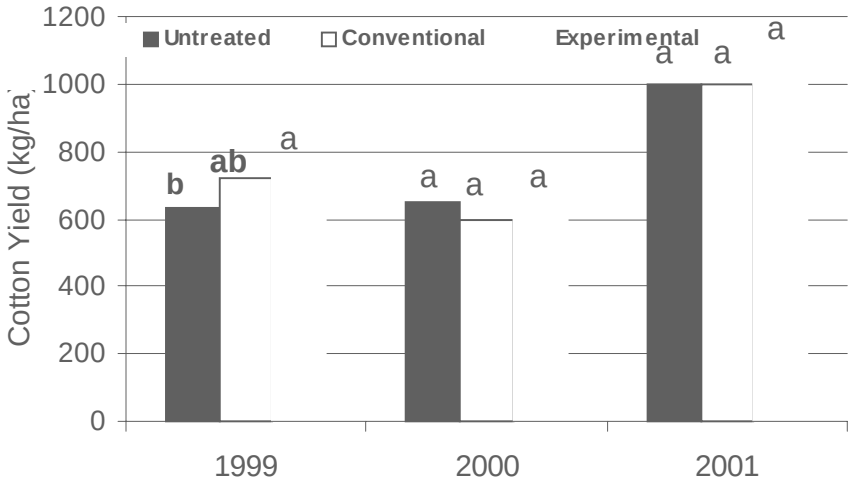

Fig. 8. Cotton lint yield results from test plots at Delta Research Station, Clarkedale, AR, 1999-2001.