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COTTON APHID (HOMOPTERA:APHIDIDAE) TREATMENT THRESHOLD INCORPORATING NATURAL ENEMIES IN ARKANSAS COTTON

Hugh E. Conway, Donald C. Steinkraus, and Timothy J. Kring
Department of Entomology
University of Arkansas
Fayetteville, AR

Abstract

The objective of this study was to incorporate the action of biological control agents in a treatment threshold for the cotton aphid, *Aphis gossypii* Glover.

Introduction

The primary means of managing the cotton aphid, *Aphis gossypii* Glover, 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. The objective of this study is to incorporate the use of beneficial insects and the entomopathogenic aphid fungus, *Neozygites fresenii,* into the decision making process for managing cotton aphid. The use of natural enemies in making treatment decisions is underutilized in row-crop agriculture.

Materials and Methods

Experimental Design

The 12 acre Clarkedale, AR 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, (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" 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
- 70 aphids/leaf if 10% visible fungus, 10% mummies, 1 coccinellid adult/row-m, 0.6 coccinellid larvae/row-m.

Aphids

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 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).

Beneficial Insects

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*).

Lint Yield

A comparison of the lint yield was made among plots based on an average of the four plots for each treatment. Cotton lint yields were taken each of the three years.

Results

Aphids

Cotton aphid populations began increasing in mid June to mid July until reaching the conventional treatment level on 18 and 25 June 1999, 28 June and 3 July 2000, and 7 and 12 July 2001 (Fig. 1). The experimental treatment threshold was reached on 25 June 1999, 3 July 2000, and 19 July 2001(Fig.1). An application of 0.22 L/ha of imidacloprid (Provado ® 1.6F Bayer Corporation, Kansas City, MO 64120) was made to appropriate plots when aphids reached the threshold levels. After the final insecticide applications, aphid populations peaked in control plots, but an epizootic of the fungus *Neozygites fresenii* caused a rapid decrease in aphid numbers. The aphid peak occurred on 29 June 1999, 6 July 2000, and 27 July 2001 (Fig. 1), aphids/leaf in the untreated plots peaked at ~140 in 1999, ~75 in 2000, and ~30 in 2001 (Fig. 1). In treated plots, aphids/leaf increased to ~50 in 1999, ~35 in 2000, and ~30 in 2001 (Fig. 1).

Beneficial Insects

The coccinellids (adult and larvae) were the dominant aphid predators present in the cotton field each year (Fig. 2). 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, ~4 in 2000, and ~0.6 in 2001 (Fig. 3). Larvae/row-m in the treated plots peaked at ~3 in 1999, ~1.5 in 2000, and ~ 0.5 in 2001 (Fig. 3).

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, ~2.7 in 2000, and ~0.5 in 2001 (Fig. 4). Adult coccinellids/row-m in treated plots peaked at ~1 in 1999, ~2 in 2000, and ~0.5 in 2001 (Fig. 4). In 2001, malathion sprays for the boll weevil eradication program that occurred on 5 and 15 June and on 3, 11, 18, and 24 July clearly affected natural enemy populations (Fig. 4).

Lint Yield

In 1999, cotton lint yield was significantly higher in plots using the experimental threshold ($P<0.05$, LSD) in comparison to untreated plots (Fig 5). There was no significant difference in yields among treatment in 2000 or 2001, and yields using conventional threshold were intermediate and not significantly different from untreated or the experimental plots.

Value of Research

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 2nd 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 year. 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 ultimately 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 2003 growing season.

References

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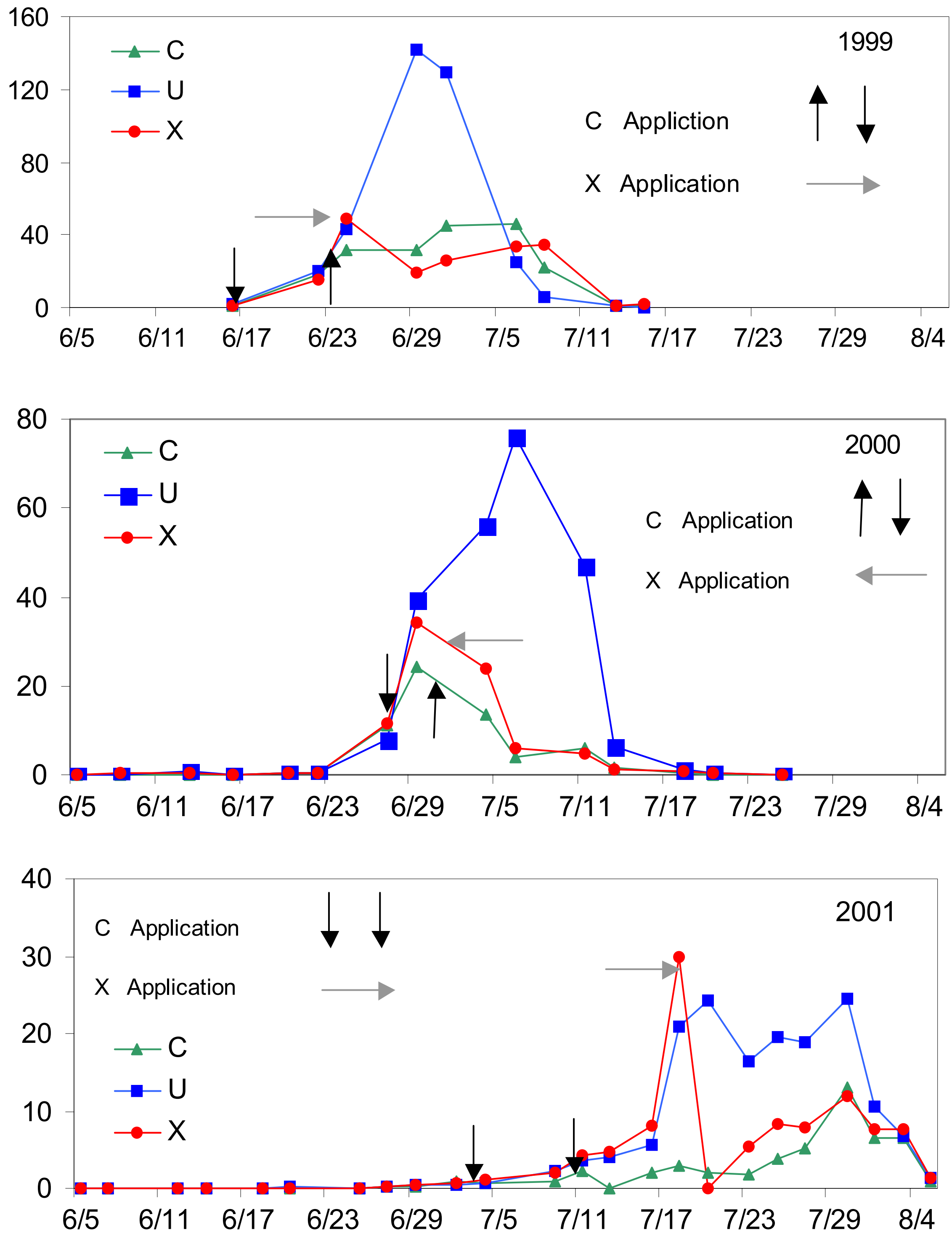

Figure 1. Aphids per leaf. 'C' indicates conventional treatment, 'U' indicates untreated, 'X' indicates experimental treatment. Imidacloprid application is indicated by arrows.

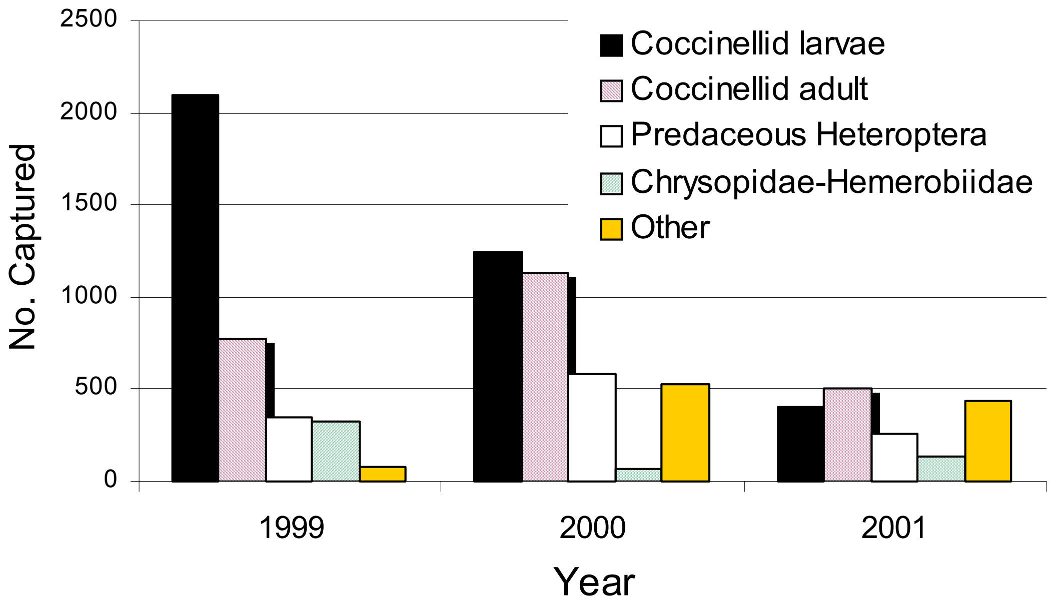

Figure 2. Comparison of beneficial insects per year from test plots in Delta Research Station (Clarkedale, AR).

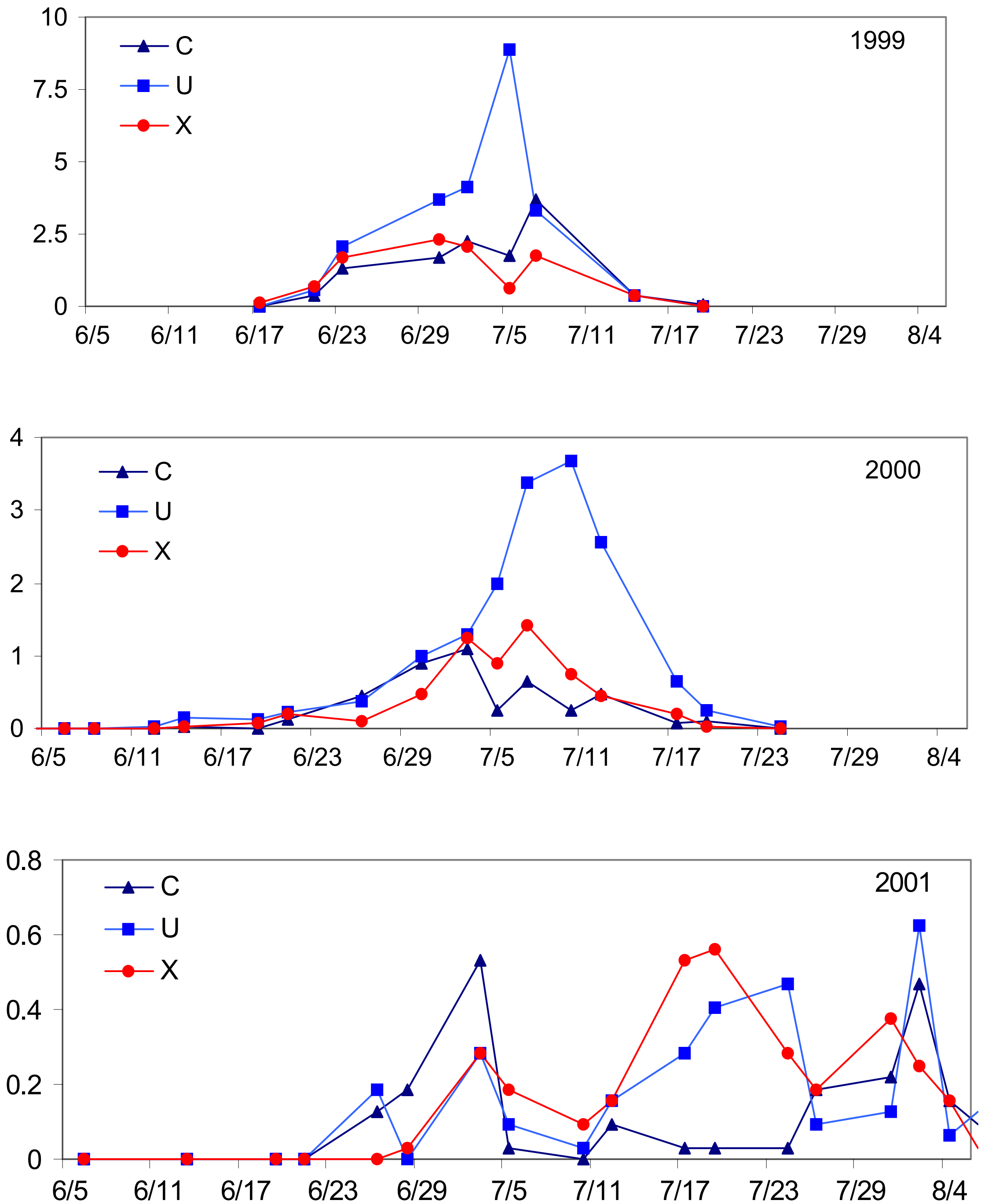

Figure 3. Larval coccinellids per row-meter. ‘C’ is conventional treatment, ‘U’ is untreated, and ‘X’ is experimental treatment.

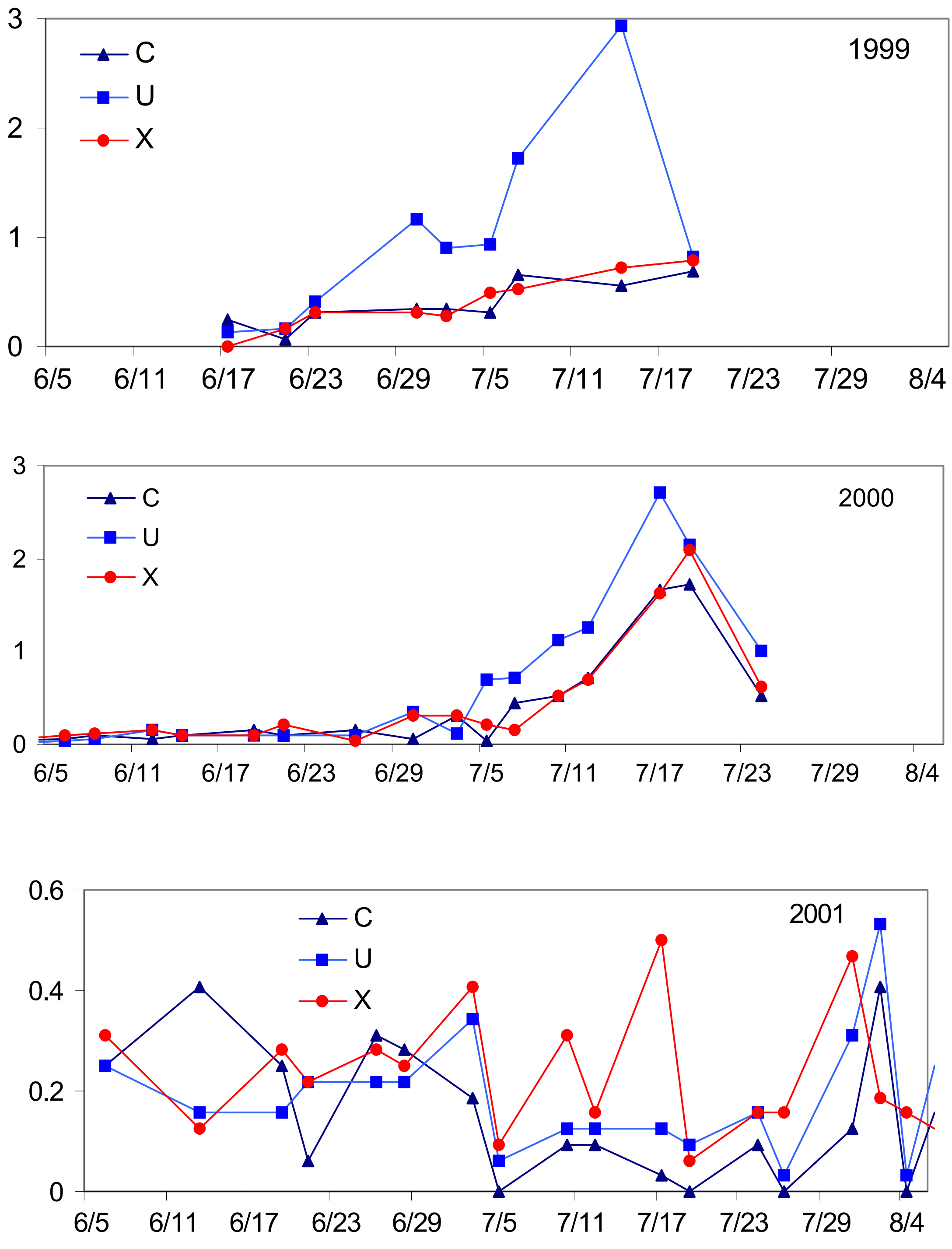

Figure 4. Adult coccinellids per row-meter. 'C' is conventional treatment, 'U' is untreated, and 'X' is experimental treatment.

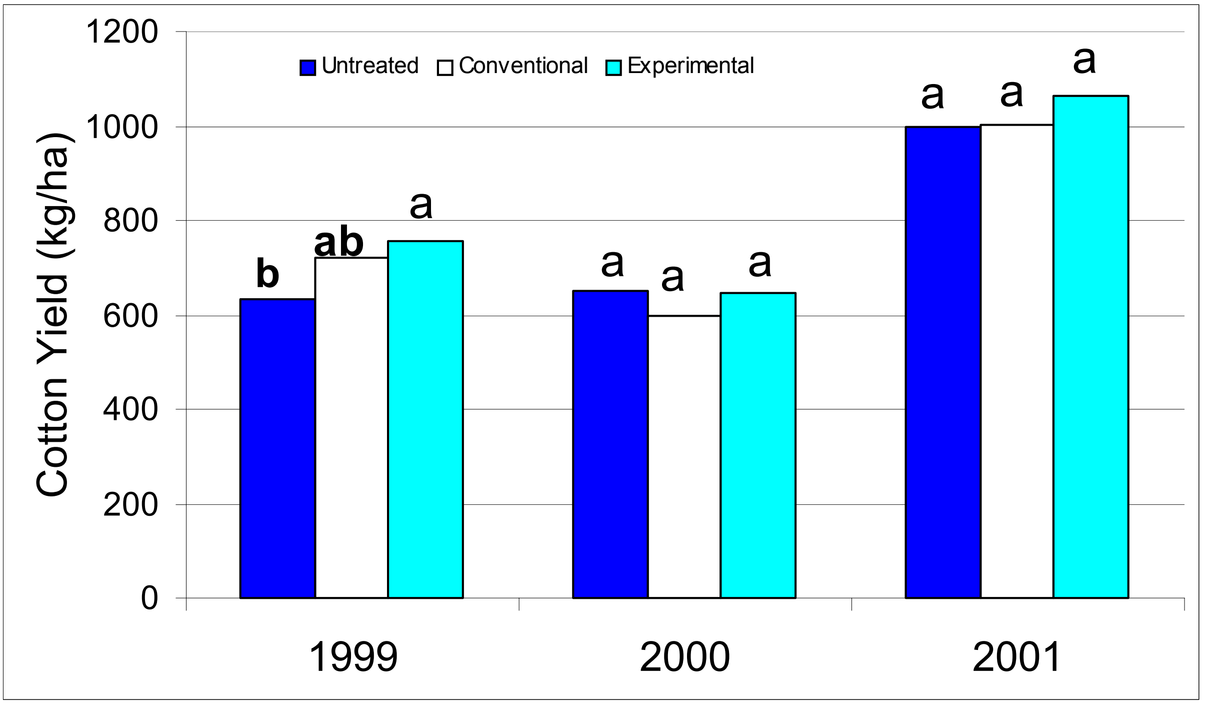

Figure 5. Cotton lint yield results from test plots at Delta Research Station (Clarkedale, AR).