INFLUENCE OF GROWER AGRONOMIC PRACTICES ON COTTON APHID POPULATIONS IN CALIFORNIA COTTON

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Abstract

The cotton aphid (*Aphis gossypii* Glover) escalated from an occasional pest to an annual pest of San Joaquin Valley (SJV) cotton during the 1990's. Although the cotton aphid is not a new insect in the SJV, the change in the bionomics of this pest dictated that new research efforts be directed toward the biology, damage thresholds, and management. Following the severe outbreak in 1997, populations and management appear to have stabilized. As a means to reduce inputs, the influence of cultural control measures on cotton aphid populations have been evaluated. Nitrogen application rate has been of particular interest. Aphid levels were monitored in seven large plot grower field studies with four differential nitrogen regimes (50 to 200 lbs./A nitrogen) during both 1999 and 2000. There was consistently a trend for more aphids in the 200 lbs./A nitrogen treatment compared with the lower treatments. In addition, the interaction between nitrogen level and pyrethroid application (a common production practice used to manage lygus bug populations) was examined. At the onset of aphid build-up, application of either a pyrethroid insecticide (Capture®) or a chloronicotinyl insecticide (Provado®) or no insecticide was superimposed. With the high nitrogen treatments (150 and 200 lbs. N/A), there were 3 to 6 times more aphids in the Capture plots compared with the untreated. The flaring effect was mitigated in the low nitrogen treatments.

Introduction

During the last 10 years, the cotton aphid, *Aphis gossypii* Glover, has developed from a non-pest to one of the most significant insect pests of California SJV cotton. In 1997, cotton aphid outbreaks were severe and widespread and an estimated 3.5% yield loss occurred. The economic impact of this pest to the California industry in 1997 totaled $34 million in crop loss and $38 million in control costs (Williams 1998). Since this "difficult" year, aphid populations have been more spotty and crop losses have been more moderate. However, significant crop production expenses have still been incurred because of aggressive management strategies for cotton aphids. Therefore, insect management plans are still enacted considering possible aphid concerns. Reasons for the upswing in the importance of cotton aphids are unclear.

One of the most noticeable changes in cotton production over the last 10 years in the SJV is the use of a plant growth regulator (mepiquat chloride) instead of irrigation and nitrogen deficits to limit early-season cotton vegetative growth. This has allowed cotton production practices in the SJV to evolve to higher nitrogen fertilization and irrigation inputs. Host plant conditions including high nitrogen and adequate moisture are generally optimal for aphid population growth and development. For instance, it was found, in a small plot study in 1997, that there were 3 times more cotton aphids on cotton in a high nitrogen treatment (200 lbs. N/A) compared with the low nitrogen treatment (50 lbs. N/A) (Cisneros and Godfrey 1998). Slosser et al. (1997) found an association between nitrogen rate and aphid numbers in Texas. These results heightened our interest in this area, as this may be a way to mitigate cotton aphid populations. Although nitrogen is a key element for growth and development of many insects, the complexities of the cotton field agroecosystem have resulted in some cases where there is no effect of nitrogen level on insect populations (Andrews et al. 2000). Nitrogen guidelines on Acala cotton varieties in the SJV are currently being reviewed and researched (Hutmacher et al. 1998, Marsh et al. 2000). The goal of our study was to investigate the influence of cotton nitrogen fertilization levels on cotton aphid populations in grower fields in the San Joaquin Valley. The interaction of lygus bug (*Lygus hesperus*) management strategies with nitrogen level on cotton aphid populations was also studied. Optimizing cotton yield through the application of appropriate nitrogen amounts while still minimizing the effects on aphid populations was the overall goal. Ideally, rather than utilizing a therapeutic approach, an increased understanding of the ecosystem can help to further minimize populations of this pest and allow continued advancement of cotton IPM.

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Procedures

Studies were conducted in 1999 and 2000 with results contributing to understanding the nitrogen-cotton aphid interaction. A portion of the results were reported in 2000; in addition, contributing studies have been reported on during previous years (Godfrey et al. 1999, Godfrey et al. 2000).

Grower Field Studies

Replicated field studies with differential nitrogen levels, set up by the Cotton Agronomist and Cotton Farm Advisors in grower fields, were utilized for the first approach. These studies were designed to evaluate the relationship between cotton nitrogen input and cotton yield and were set up as strip tests, generally 8 rows wide x the field length (up to 1/4 mile long) x 4 blocks. Target nitrogen rates in these studies were 50, 100, 150, and 200 lbs. N/A; the lowest rate utilized the residual soil nitrogen and was 70 lbs./A nitrogen at one location. The three highest rates were the residual plus the appropriate amount of applied N. Field sites were located in grower fields in Tulare Co., Fresno Co. (2000 only), Kings Co., Merced Co., Madera Co., and Kern Co. (1999 only). Two Univ. of California Research and Extension Centers were also utilized (Shafter and West Side) and the row lengths were ~300 ft. at these two locations. Planting dates varied across locations but were generally in mid-late April in 1999 and early April in 2000. Nitrogen was generally applied in early to mid June. Cotton aphid populations were sampled at weekly intervals from each plot from July to September. A twenty-leaf sample, fifth main stem node leaf from the top, was used. Aphids were counted with the aid of 50X magnification. Aphid density, morph, and incidence of alates were recorded for each sample.

Nitrogen-Pyrethroid Insecticide Interaction

The second experiment was designed to study the interaction between a pyrethroid insecticide and nitrogen level on aphid population dynamics. The pyrethroid insecticides are used for lygus bug management (Godfrey et al.1998); they are among the most effective products for control of this pest, but have the drawbacks of destroying populations of natural enemies and stimulating aphid reproduction. Several researchers have noted an increase in cotton aphid numbers following pyrethroid insecticide application. The flaring of aphid populations with lambda-cyhalothrin (Kidd et al. 1996) and with bifenthrin and cyfluthrin (Godfrey 1998) have been demonstrated. Therefore, in independent studies, nitrogen rate and pyrethroid applications have been shown to influence aphid numbers. In this study, nitrogen rates of 0 (actually had ~20 lbs./A N from a soil residual source), 50, 100, 150, and 200 lbs. N/A were applied in mid-late June to a cotton plot planted in early May. Insecticide treatments of Capture® 2E at 0.06 lbs. AI/A, Provado® 1.6F at 0.047 lbs. AI/A and an untreated were superimposed across the nitrogen treatments. Insecticide applications were made on 19 Aug. in 1999 and on 26 July in 2000 to plots 8 rows by 90 feet by 4 blocks. Applications were delayed until aphid populations started to build which corresponded with ~5 and 30 aphids per leaf in 1999 and

2000, respectively. Aphid populations were quantified weekly, as previously described, during Aug. and Sept. Cotton yields were quantified by harvesting the middle two rows in Oct.

Results

Grower Field Studies

Cotton aphid populations were generally low in 1999, but levels responded to nitrogen regime. In the grower field strip tests, aphid populations developed in five of the seven sites with the highest aphid density seen being 9 per leaf; a 3-4X increase was seen from the 50 to 200 lbs./A treatments (Godfrey et al. 2000).

In 2000, aphid populations were higher than in 1999 and developed earlier in the season. Averaging all seven fields, levels peaked in mid-August (Fig. 1). Populations were similar in the 50, 100, and 150 lbs. nitrogen/A treatment and averaged ~32 aphids/leaf. In the 200 lbs. nitrogen/A treatment, populations averaged ~75/leaf. The percentage aphid-infested leaves responded weakly to nitrogen rate.

Populations in individual fields responded clearly to nitrogen level. A field located in Merced Co. showed a clear delineation of the aphid populations by nitrogen treatment (Fig. 2). Populations peaked at 217 aphids/leaf in the 200 lb./A treatment compared with 50 aphids/leaf in the 50 lb./A treatment.

Nitrogen-Pyrethroid Insecticide Interaction

In 1999, cotton aphid populations in untreated plots were generally higher with increasing nitrogen levels (10.9 to 24.8 aphids per leaf at 20 to 200 lbs./A nitrogen). Provado controlled the infestation. At 150 and 200 lbs./A nitrogen, there were 3 and 4 times, respectively, more aphids in the Capture-treated compared with the untreated, whereas at 0 to 100 lbs./A nitrogen, the aphid population was 50-75% higher in the Capture-treated plots compared with the untreated (Godfrey et al. 2000).

In 2000, at 3 weeks following the insecticide application in the untreated plots, aphid numbers increased across the increasing nitrogen levels (0 to 36 aphids per leaf from 0 to 200 lbs./A nitrogen) (Fig. 3). Provado controlled the infestation which is in agreement with its activity spectrum. At 100 and 150 lbs./A nitrogen, the aphid population was 2X higher in the Capture-treated plots compared with untreated and it was 6 times higher (Capture compared with untreated) in the 200 lbs./A nitrogen treatment.

Seed cotton yields ranged from 1369 (Provado with 20 lbs./A nitrogen) to 2826 lbs./A (untreated with 200 lbs./A nitrogen). Across the insecticide treatments, yields were numerically highest with 100 lbs./A nitrogen (2650 lbs./A seed cotton) and fell off slightly with more nitrogen (200 lbs./A produced 2469 lbs./A seed cotton) and less nitrogen (20 lbs./A nitrogen produced 1733 lbs./A seed cotton). Seed cotton yields varied only slightly across the insecticide treatment main effects.

Summary

Nitrogen level appears to be an important factor in altering cotton aphid population levels with high nitrogen inputs promoting higher aphid populations in cotton. In addition, there is an interaction between nitrogen rate and insecticide application on aphid numbers. A pyrethroid insecticide flared the aphid population to a greater extent under high (200 lbs./A) than under a lower (0 to 50 lbs./A) nitrogen regime. Specific aspects of the California cotton production system may intensify this effect compared with other production areas. The nitrogen rate used, nitrogen application timing, i.e., applied entirely post-emergence, cotton variety, and irrigation use may be important factors which promote this effect.

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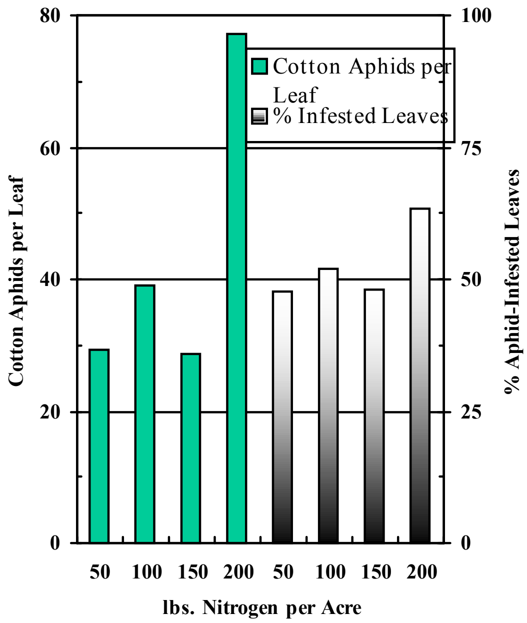

Figure 1. Effects of nitrogen rate on cotton aphid populations in studies conducted in grower fields. Data are the average of seven locations in the San Joaquin Valley in 2000.

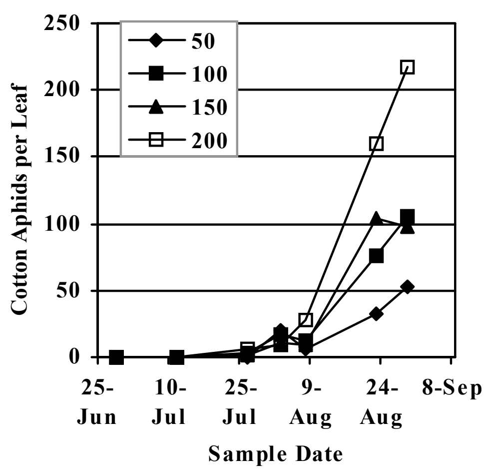

Figure 2. Effect of nitrogen application rate on cotton aphid population levels at a Merced Co. site, 2000.

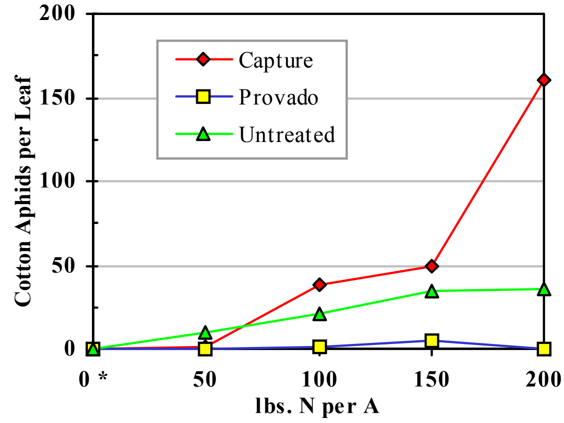

Figure 3. Cotton aphid populations as influenced by nitrogen application rate and insecticide application (data collected 3 weeks after application) in 2000.
* = 20 lbs./A residual nitrogen in soil, other treatments adjusted accordingly for this residual.