USING ^{15}N IN DEFINING NITROGEN FERTILIZATION GUIDELINES

F. B. Fritschi1, D. W. Rains and R. L. Travis
University of California
Davis, CA
B. A. Roberts
University of California Cooperative Extension
Hanford, CA

Abstract

Economically and environmentally sound crop production entails, among other things, efficient use of N inputs. This research was conducted to determine the response of irrigated Acala cotton to different N fertilization rates, and to track applied ^{15}N fertilizer over time. Cotton was grown at two locations in the San Joaquin Valley (CA), on a Typic Haplocambid (clay loam) and a Typic Torriorthent (sandy loam). At both locations N treatments of 50, 100, 150, and 200 lb acre^{-1} were established as a randomized complete block design with four replications. Microplots established in the 50 and the 150 lb acre^{-1} treatments were fertilized with ^{15}N Urea. Response of lint yield to N treatment was absent or minimal at both locations. However, total biomass accumulation increased with increasing N application rates. The absence of a strong yield response indicates a high supply power of the soil from mineral soil N in the spring and N mineralization during the growing season.

Introduction

Cotton is among the most important, if not the most important, agronomic crop in California. Cultivars currently grown in California produce lint yields that are among the highest in the world. Nutrients, water and other inputs need to be managed with great care in order to obtain such high yields. Many production guidelines currently available to California cotton producers, including those for nitrogen (N) fertilization, were developed in the 1960's. Production practices as well as cotton cultivars have undergone a change since then, thus adaptation of the production guidelines to the new situation is necessary. Meredith et al. (1997) documented the changes in cotton varieties over time. They found that modern cotton varieties, for example, are more determinant, earlier maturing, set and fill bolls over a shorter period of time, and respond more strongly to nitrogen applications than obsolete varieties.

Nitrogen nutrition plays a critical role in cotton production. In particular the balance between vegetative and reproductive growth is dramatically affected by nitrogen availability. In addition, N management also affects the likelyhood of aphid infestations (Cisneros and Godfrey, 1998), as well as defoliation efficiency (Johnson-Hake et al., 1996). Depending on soil type and cropping history current N fertilization rates in California vary between 150 and 200 lb per acre but may occasionally exceed 200 lb per acre. Based on a 200 lb per acre N application rate and assuming an average annual cotton production of one million acres, cotton accounts for almost 20% of all agricultural N use in California. Evaluation of California Central Valley well water has shown an increase in nitrate concentrations over the past ten years. The increase has been attributed largely to non-point sources (Water-Resources Investigations, Report 98-4040). These findings may have considerable implications for cotton production and California agriculture in general since management of nitrate contamination in groundwater is coming under increasing scrutiny. The critical role of N in cotton management warrants a reevaluation of its application guidelines tailoring its management to new cultivation practices and recognizing widespread environmental concerns.

Ongoing studies show very small or no yield responses to fertilizer N at several locations throughout the San Joaquin Valley. This study was conducted to further the understanding of N dynamics in the cotton production system as it exists in the Central Valley. A better awareness of the N pools and the mechanisms and processes that result in the observed yield responses or absence thereof will facilitate adaptations of fertilization practices to new production requirements and environmental considerations.

Methods

In spring 1998 a field study was initiated at two sites in the San Joaquin Valley. The two sites differ in soil characteristics, one being a sandy loam (Typic Torriorthent) and the other a clay loam (Typic Haplocambid). The variety planted at both locations was Maxxa. Four N treatments each with four replications (50, 100, 150, and 200 kg N ha^{-1}) were established as a randomized complete block design at each location. Microplots for applications of ^{15}N Urea were established in each replication of the 50 and 150 kg N ha^{-1} treatments. Six destructive plant samplings were conducted over the course of the season in each microplot. A number of variables including dry weight of leaves, stems, and fruiting structures, leaf area, and plant growth characteristics were determined. All treatments were analyzed for yield. Subsamples of plant materials collected throughout the season were analyzed for total N and for atom % ^{15}N.

Results and Discussion

Lint yields did not differ significantly between the two locations except for the 100 lb acre^{-1} treatment (Figure 1). Lint yields were not different between the treatments at the Fresno Co. location. At the Kings Co. site the difference was

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1387-1388 (2000)
National Cotton Council, Memphis TN

significant only between the 100 and 150 lb acre^{-1} treatments. Above ground biomass production responded positively to increased N fertilizer applications at both sites (Figure 2). The amount of above ground biomass accumulated at defoliation was higher at the Fresno than at the Kings Co. site. These results suggest that at least in years like 1998, N fertilization rates could be lowered without significant reductions in lint yield. This may be particularly true for cotton grown in rotation with other crops after which high residual soil nitrate levels can be found. Preliminary ^{15}N data indicate higher recovery of fertilizer N in the clay loam (Fresno Co.) than in the sandy loam (Kings Co.). This may contribute to the larger amount of above ground biomass produced at the Fresno Co. location.

References

Cisneros, J.J. and L.D. Godfrey. 1998. Agronomic and environmental factors influencing the control of cotton aphids with insecticides. 1998 Beltwide Cotton Conf. Proc. San Diego, CA.

Johnson-Hake, S., T.A. Kerby, and K.D. Hake. 1996. Preharvest/harvest decisions. Pp. 73-81. In: Cotton Production Manual, University of CA Cooperative Extension, Publication No. 3352.

Meredith, W.R., Jr., J.J. Heitholt, W.T. Pettigrew, and S.T. Rayburn, Jr. 1997. Comparison of obsolete and modern cotton cultivars at two nitrogen levels. Crop Sci. 37:1453-1457.

Water-Resources Investigations Report 98-4040. 1998. Nitrate and pesticides in ground water in the eastern San Joaquin Valley, California: occurrence and trends. U.S. Department of the Interior.

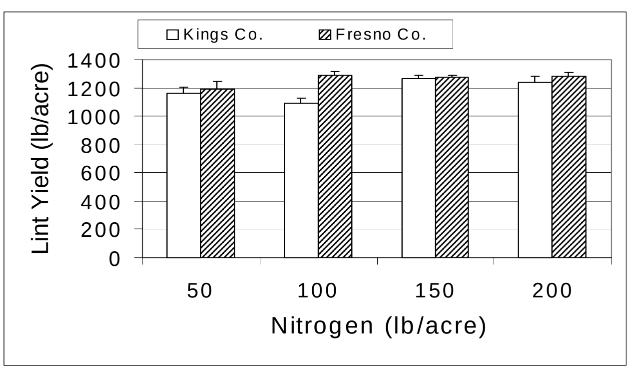

Figure 1. Effect of N fertilization on cotton lint yield at the Kings County and the Fresno County sites in 1998.

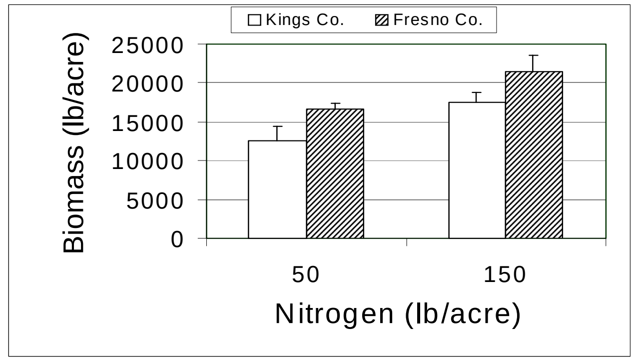

Figure 2. Effect of N fertilization on above ground biomass at the time of defoliation at the Kings County and the Fresno County sites in 1998.