

Nitrogen Management Experiments For Upland and Pima Cotton, 1998

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Abstract

Two field experiments were conducted in Arizona in 1998 at two locations (Maricopa and Marana). The Maricopa experiment has been conducted for nine consecutive seasons, the Marana site was initiated in 1994. The purposes of the experiments were to validate and refine nitrogen (N) fertilization recommendations for Upland cotton. The experiments each utilized N management tools such as pre-season soil tests for NO_3^- -N, in-season plant tissue testing (petioles) for N fertility status, and crop monitoring to ascertain crop fruiting patterns and crop N needs. At each location, treatments varied from a conservative to a more aggressive approach of N management. Results at each location revealed a strong relationship between the crop fruit retention levels and N needs for the crop. This pattern was further reflected in final yield analysis as a response to the N fertilization regimes used. The higher, more aggressive, N application regimes did not benefit yields at any location. In 1998, fruit retention levels were low and crop vigor was high. As a result, even slight increases in N fertilization and crop vigor translated into lower yield.

Introduction

The management of fertilizer nitrogen (N) is a very important component of any cotton (*Gossypium* spp.) production program in Arizona. Water, and N are normally the most limiting inputs to successful cotton production in most desert soils. It is important for farmers to use fertilizer N efficiently to maintain optimum return in yield for the amount of fertilizer N provided. Also, from an environmental standpoint, it is important to manage fertilizer N so that downward movement of NO_3^- -N in the soil profile, can be minimized.

For cotton production systems in the desert Southwest, there are several N management tools available to manage fertilizer N inputs efficiently in terms of economic, agronomic, and environmental concerns. Nitrogen management tools include: residual soil NO_3^- -N levels from pre-season soil samples, inputs of NO_3^- -N through irrigation water, petiole samples taken in-season for NO_3^- -N analysis, fruit load and growth pattern measurements of the crop in terms of N needs, and the use of split applications of fertilizer N through the course of the season (Silvertooth and Doerge, 1990).

Recommendations from University of Arizona Cooperative Extension personnel concerning N management in cotton usually include the aforementioned tools. Fertilizer N applications based purely on conjecture or guesswork are discouraged. The two field experiments conducted in 1998 serve as an extension of consecutive experiments from 1989 through 1998 (Silvertooth et al., 1990; Silvertooth et al., 1991b; Silvertooth et al., 1992; Silvertooth et al., 1993; Silvertooth et al., 1994; Silvertooth et al., 1995; Silvertooth and Norton, 1996; Silvertooth and Norton, 1997; and Silvertooth and Norton, 1998) to develop and refine guidelines for recommendations concerning the integration of N management tools to improve overall efficiency for the grower. Objectives for these experiments are: 1) to compare several fertilizer N management strategies for cotton in terms of N fertility status of the crop, and yield; and 2) develop refinements in the fertilizer N recommendations associated with in-season N fertility assessments using cotton petiole analysis and fruit load development.

Materials and Methods

Field experiments were conducted in 1998 at the University of Arizona Maricopa Agricultural Center (MAC) and the Marana Agricultural Center (MAR).

Upland cotton (*G. hirsutum* L., var. DP 33b) was dry-planted and watered-up on a Casa Grande sandy loam on 21 April at Maricopa. The experimental structure was a split plot within a randomized complete block design with three replications. The N treatments are outlined in Table 1. Plots were eight, 40 inch rows wide and extended the full length of the irrigation run (600 ft.). At Marana, Upland cotton (var. STV 474), was planted on 17 April in plots which were eight, 40 inch rows wide and 600 ft. in length, with N treatments (Table 1) arranged in a randomized complete block design with four replications. All pest control and irrigation management practices were carried out on optimum, an as-needed basis at each location.

Surface soil samples were collected preseason at each location, to which routine soil analyses were performed.

Basic plant measurements were carried out within each plot on a regular 14 day interval for the entire season. These measurements included plant heights, number of mainstem nodes per plant, flower numbers per 167 ft.² area, and the number of nodes above the top white flower to the terminal (NAWF). Petioles were also sampled on a routine basis throughout the season and analyzed for NO₃⁻-N. Plant mapping was performed on each distinct treatment (variety and N treatment) at 14 day intervals during the course of the season. Results from the plant mapping provide information concerning the percent total fruit retention (sum of positions one and two on each fruiting branch) for each treatment, a record of the general vegetative/reproductive balance maintained by the various treatments over time, and maturity progress.

The N fertilization regimes utilized at each location are outlined in Tables 2 and 3 for Maricopa and Marana, respectively. Final irrigations and harvest dates were 8 September and 18 November, at Maricopa and 10 September and 17 November at Marana.

Lint yields were obtained for each treatment by harvesting the entire center four rows of each plot with a two row mechanical picker. Seedcotton subsamples were collected for ginning, from which lint turnout estimates were made. Results were analyzed statistically in accordance to procedures outlined by Steel and Torrie (1980) and the SAS Institute (SAS, 1988).

Results

Fruit retention (FR) and height to node ratio (HNR), and petiole analysis results are presented for all locations, varieties, and treatments in Figures 1, 2, and 3. Lint yield results are presented in Table 4.

Maricopa

Fruit retention levels, plant vigor estimates (height to node ratios, HNR) developed from the plant mapping data, and petiole NO₃⁻-N concentrations are shown in Fig. 1 for the DP (NuCOTN) 33b. Early season low plant vigor resulted in low HNRs. Fruit retention patterns were generally low all season, which contributed to rapid increases in HNRs from early bloom throughout the season. A substantial boll load, which would indicate a strong N sink and a high N demand, did not develop for this crop. Visual symptoms of N deficiency were not apparent in the check plots at any time in the season. However, the petiole NO₃⁻-N levels in the check plots dropped early in the season. The FR and HNR patterns were similar for all treatments. However, slightly higher HNRs were noted for treatment 4 plots that received higher N rates.

Yield data is shown in Table 4. Significant differences were detected among the N treatments with the feedback treatment (treatment 3) providing the highest overall yield. Treatment 3 resulted in a very conservative approach to N fertilization (90 lbs. N/acre total) and was significantly higher in yield than the check (treatment 1) or a more aggressive N treatment 2 (225 lbs. N/acre total). The yield results in relation to the N fertilization schemes employed are consistent with several of the previous seasons.

Marana

The STV 474 at Marana developed a very poor fruit load (Figure 2) and experienced a drastic drop in FR near first bloom (~1200 HUAP), primarily in relation to a severe infestation of lygus bugs. Fruit retention levels did not recover substantially for the rest of the season. Plant vigor (HNR) patterns were low early in the season but increased rapidly to levels above the optimum baseline beyond mid-season. In general, the relationships between the FR and HNR levels experienced at Marana in 1998 are common with respect to crop vegetative/reproductive balance when FR levels are low.

Lint yield results (Table 4) revealed significant differences among the N fertilization treatments, with the check plot (0 lbs. N/acre applied as fertilizer) yielding the highest. However, it is interesting to note that the highest rates of N fertilization with treatments no. 4 and 2 (200 lbs. N/acre) provided the lowest yields and generally the most vigorous (vegetative) plants. The petiole NO_3^- -N concentrations experienced with treatment 1 (Figure 2) are consistent with optimum patterns demonstrated in previous studies.

Even a conservative approach to N management, as employed in treatment 3 (100 lbs. N/acre total), caused a reduction in lint yield relative to the check. This does not indicate that N fertilizer recommendations should advocate zero N fertilization in many cases. But it does reinforce the use of a conservative approach to N management in relation crop condition. In the case of the Marana study in 1998, clearly a single application of 50 lbs. N/acre (e.g. on 4 June) would have sufficed for crop needs. It also would have protected the crop in terms of potential N needs in the event that the FR levels could have been markedly improved later in the season.

Summary

The 1998 cotton season in Arizona was very difficult for many growers in terms of crop management (late start, vegetative growth, and poor yields) and profitability. The patterns of crop growth experienced at both locations with this project were representative of crop growth conditions and problems commonly encountered across many parts of the State in 1998. These results reveal the sensitive nature of the vegetative/reproductive balance of a cotton crop and serve to reinforce the use of plant measurements in an attempt to gain an assessment on the FR and HNR status of the crop for use in adjusting N fertilization accordingly. These results are also consistent with results from previous years with this project that have demonstrated the value of a conservative approach to fertilizer N management in irrigated cotton.

Acknowledgements

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Table 1. Nitrogen fertilization treatments used at the Maricopa, and Marana Agricultural Centers, 1989-1998.*

N Treatment Number	Fertilizer N Management
1	Check (No fertilizer N)
2	Standard: Preplant & Side-dress
3	Feedback approach from soil and petiole NO_3^- -N analysis, 1X rate
4	2X rate from soil and petiole NO_3^- -N feedback

* The Marana location was initiated in 1994.

Table 2. Fertilizer N applications for each N management treatment, MAC, 1998.

N Management Treatment						
Date	Form	Method	1	2	3	4
			lbs. N/acre			
8 May	21-0-0	SD	0	45	0	0
1 June	21-0-0	SD	0	45	45	90
17 June	21-0-0	SD	0	90	45	90
17 July	21-0-0	SD	0	45	0	0
Total			0	225	90	180

Table 3. Fertilizer N applications for each N management treatment, Marana, 1998.

N Management Treatment						
Date	Form	Method	1	2	3	4
			lbs. N/acre			
12 April	21-0-0	SD*	0	50	0	0
4 June	21-0-0	SD	0	50	50	100
24 June	21-0-0	SD	0	100	50	100
Total			0	200	100	200

*Sidedress

Table 4. Lint yields from Maricopa and Marana N-management studies, 1998.

Treatments	Lint Yield (lbs. lint/acre)
Maricopa	
DPL 33B	
3	1251 a*
4	1203 ab
1	1137 bc
2	1081 c
OSL	0.0218
C.V. (%)	5.49
LSD ($\alpha=0.05$)	103
Marana	
Stoneville 474	
1	1109 a*
3	1006 b
2	976 b
4	919 c
OSL	0.0002
C.V. (%)	3.31
LSD ($\alpha=0.05$)	53

* Means followed by the same letter are not significantly different ($\alpha=0.05$) according to a Duncan's means separation test.

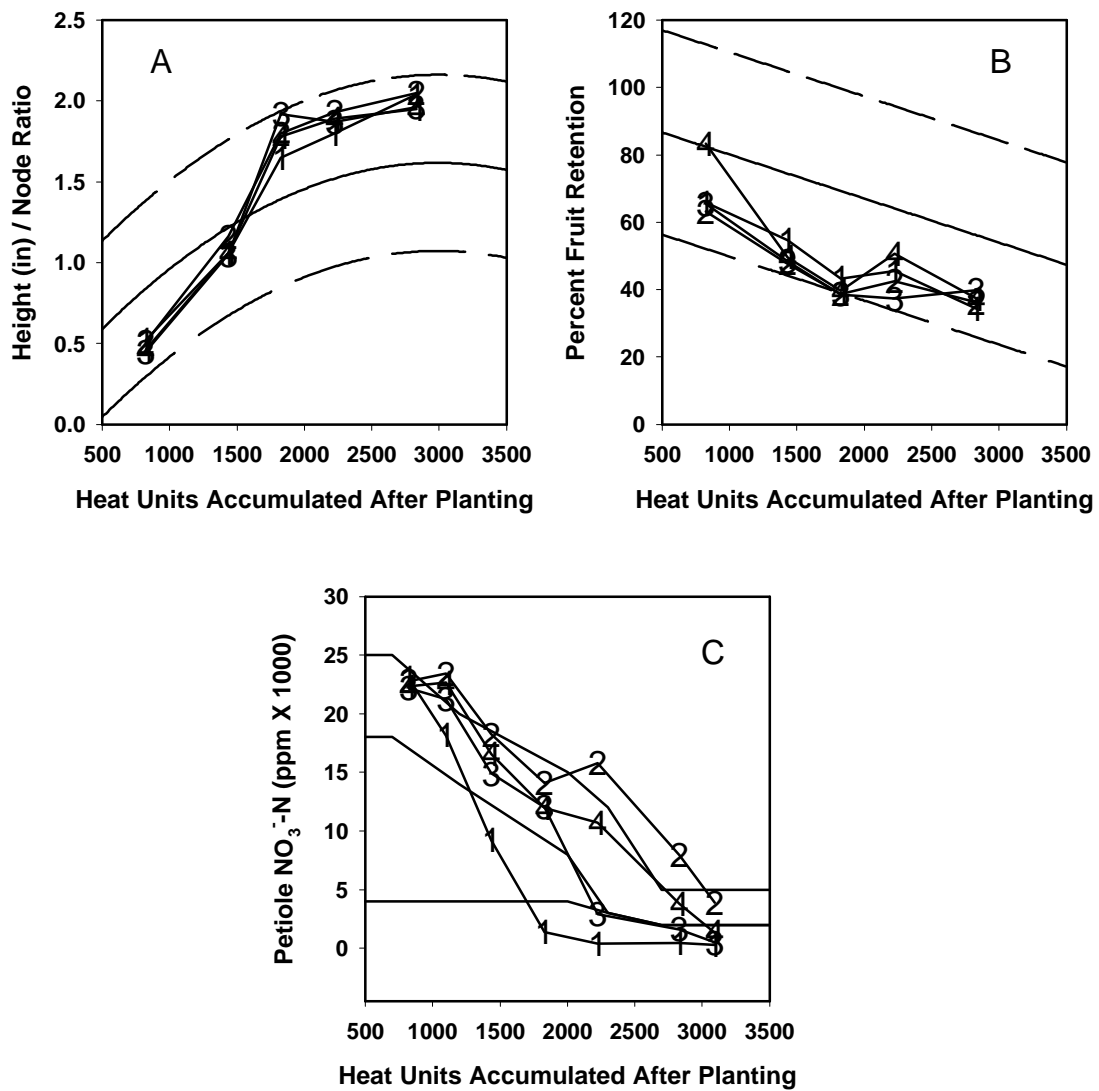


Figure 1. Height to node ratio (A), fruit retention (B), and petiole N levels for N-management study, Maricopa, 1998.

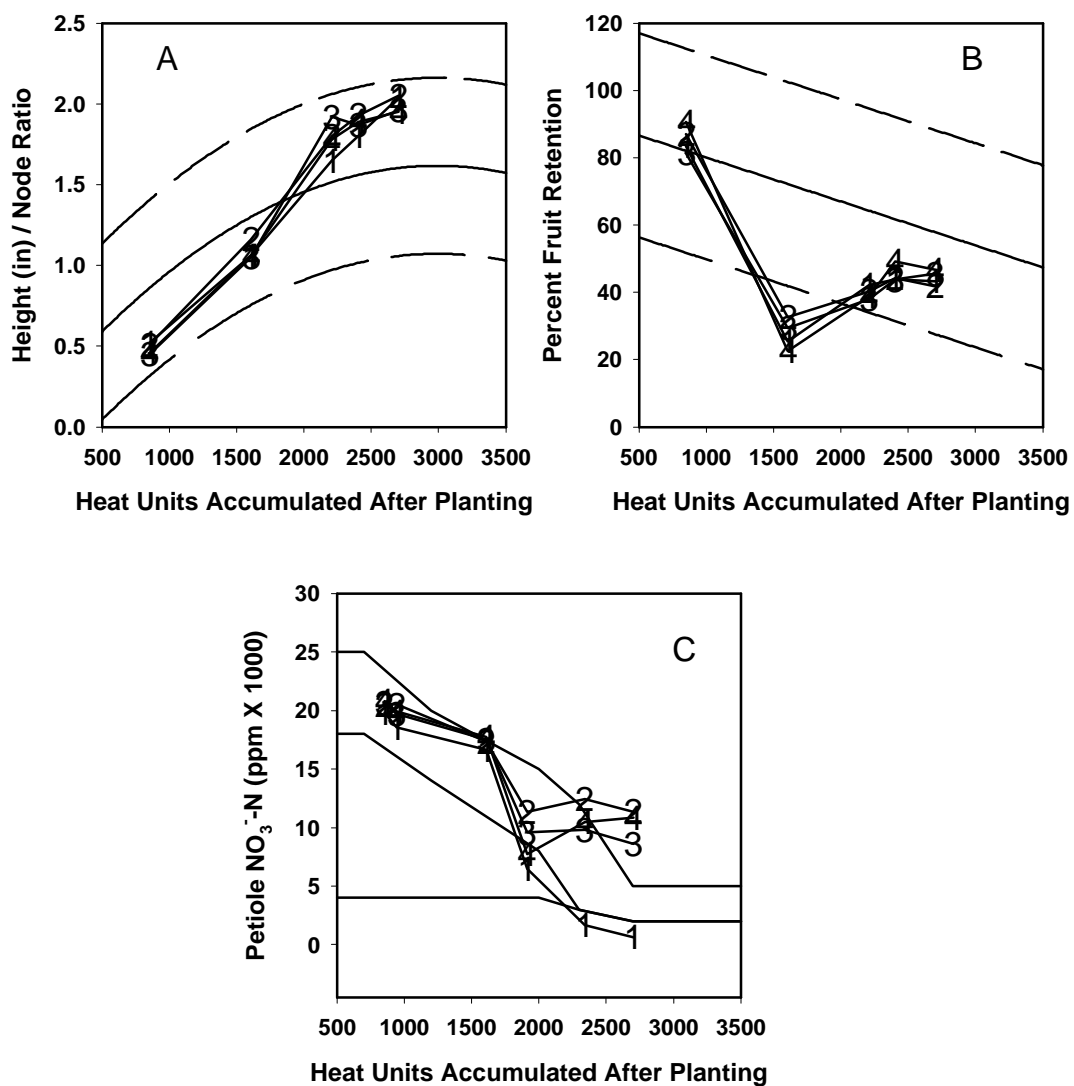


Figure 2. Height to node ratio (A), fruit retention (B), and petiole N levels for N-management study, Marana, 1998.