

# Nitrogen Management Experiments For Upland and Pima Cotton, 1999

J. C. Silvertooth and E.R. Norton

## Abstract

*Two field experiments were conducted in Arizona in 1999 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<sub>3</sub><sup>-</sup>-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 1999, fruit retention levels were low and crop vigor was high at the Maricopa site. 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<sub>3</sub><sup>-</sup>-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<sub>3</sub><sup>-</sup>-N levels from pre-season soil samples, inputs of NO<sub>3</sub><sup>-</sup>-N through irrigation water, petiole samples taken in-season for NO<sub>3</sub><sup>-</sup>-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; Silvertooth and Norton, 1998; and Silvertooth and Norton, 1999) 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 1999 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 13 April at Maricopa. The experimental structure was a randomized complete block design with four 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. DP 33b), was planted into moisture on Pima clay loam soil on 14 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 pre-season 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.<sup>2</sup> 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 NO<sub>3</sub><sup>-</sup>-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 31 August and 9 November, at Maricopa and 23 August and 20 October 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. Fertilizer N use efficiency (FUE) estimates were made consistent with the methods outlined by Norton and Silvertooth, (1998) and Navarro et al. (1997). 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 - 4. 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 NO<sub>3</sub><sup>-</sup>-N concentrations are shown in Fig. 2 for the DP (NuCOTN) 33b. Early season low plant vigor resulted in low HNRs (Fig. 1). 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. Poor FR was attributed to a lygus bug infestation that began relatively early in the season, before first bloom (~ 1100 HUAP) and persisted for many weeks, despite diligent efforts for control. Visual symptoms of N deficiency were not apparent in the check plots at any time in the season. The FR and HNR patterns were similar for all treatments.

Yield data is shown in Table 4. Significant differences were detected among the N treatments with the check treatment (treatment 1) providing the highest overall yield. Treatment 3 resulted in a very conservative approach to N fertilization (90 lbs. N/acre total) and was not significantly lower in yield than the check (treatment 1) but was slightly higher than the more aggressive N application regimes of treatment 2 (225 lbs. N/acre total) and treatment 4 (220 lbs. N/acre total). Treatment 4 was significantly lower in yield than treatments 1 and 3. The yield results in

relation to the N fertilization schemes employed are generally consistent with several of the previous seasons. Due to the fact that the check plots (0 fertilizer N applied) provided the highest yields, estimates of FUE were negative for each fertilizer N treatment, ranging from -8 % (treatment 3) to -10% (treatment 2).

### Marana

The DP 33b at Marana developed a very strong fruit load (Figure 2) but did experience a distinct drop in FR near first bloom (~1200 HUAP), primarily in relation to a moderate infestation of lygus bugs. Fruit retention levels recovered substantially through the mid to later portion of the fruiting cycle. Plant vigor (HNR) patterns were low early in the season but increased rapidly to levels near the optimum baseline beyond mid-season. In general, the relationships between the FR and HNR levels experienced at Marana in 1999 are common with respect to crop vegetative/reproductive balance when FR levels are satisfactory.

Lint yield results (Table 4) revealed significant differences among the N fertilization treatments, with the treatment 3 plots (feedback approach with 90 lbs. N/acre total 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 (180 lbs. N/acre total) provided the lower yields than treatment 3.

A conservative approach to N management, as employed in treatment 3 (90 lbs. N/acre total) was sufficient for crop needs and optimum yields. However, FUE estimates were relatively low. Estimates of FUE were the highest for treatment 3 (16%) and lowest for treatment 2 (5%).

### **Summary**

The 1999 cotton season in Arizona was very difficult for many growers in terms of crop management (late start and relatively poor early season vigor). 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 1999. 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, 1989-1999.\*

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

\* The Marana location was initiated in 1994.

Table 2. Fertilizer N applications for each N management treatment, MAC, 1999.

Date	Form	Method	N Management Treatment			
			1	2	3	4
			lbs. N/acre			
13 April	21-0-0	SD	0	40	0	0
28 May	21-0-0	SD	0	35	35	70
14 June	21-0-0	SD	0	70	35	70
24 June	21-0-0	SD	0	40	40	80
12 July	21-0-0	SD	0	40	0	0
<b>Total</b>			<b>0</b>	<b>225</b>	<b>115</b>	<b>220</b>

Table 3. Fertilizer N applications for each N management treatment, Marana, 1999.

Date	Form	Method	N Management Treatment			
			1	2	3	4
			lbs. N/acre			
14 April	21-0-0	SD*	0	50	0	0
3 June	21-0-0	SD	0	50	50	100
29 June	21-0-0	SD	0	80	40	80
<b>Total</b>			<b>0</b>	<b>180</b>	<b>90</b>	<b>180</b>

\*Sidedress

Table 4. Lint yields from Maricopa and Marana N-management studies, 1999.

Treatments	Lint Yield (lbs. lint/acre)
<b>Maricopa</b>	
<b>DPL 33B</b>	
1	1300 a*
3	1223 ab
4	1159 bc
2	1110 c
OSL	0.0072
C.V. (%)	4.93
LSD ( $\alpha=0.05$ )	95
<b>Marana</b>	
<b>DPL 33B</b>	
3	1083 a*
4	1075 ab
2	1053 b
1	983 c
OSL	0.0001
C.V. (%)	1.54
LSD ( $\alpha=0.05$ )	26

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

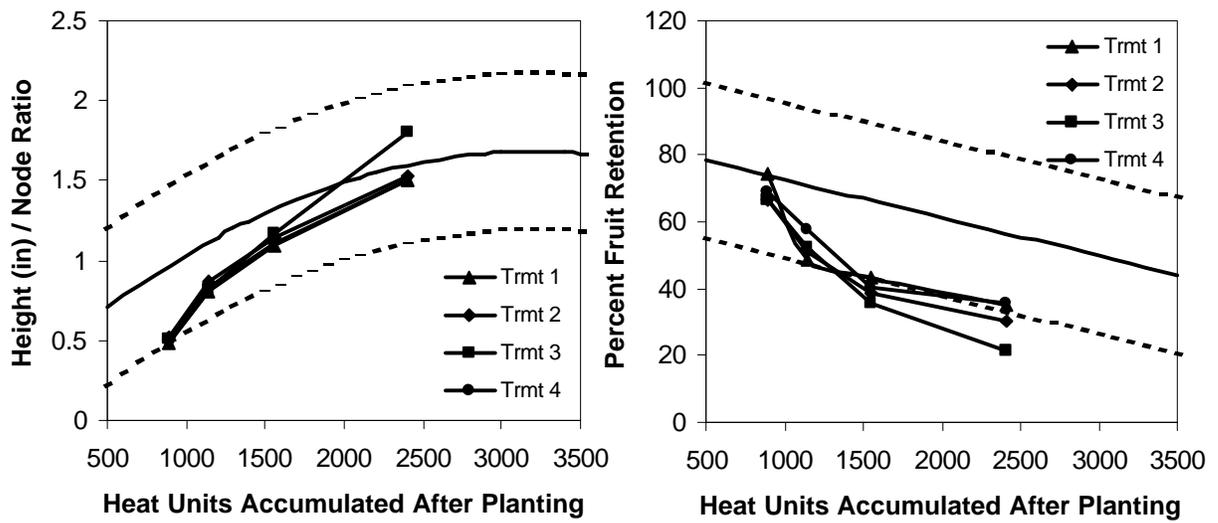


Figure 1. Height to node ratio and fruit retention levels for N-management study, Maricopa, 1999.

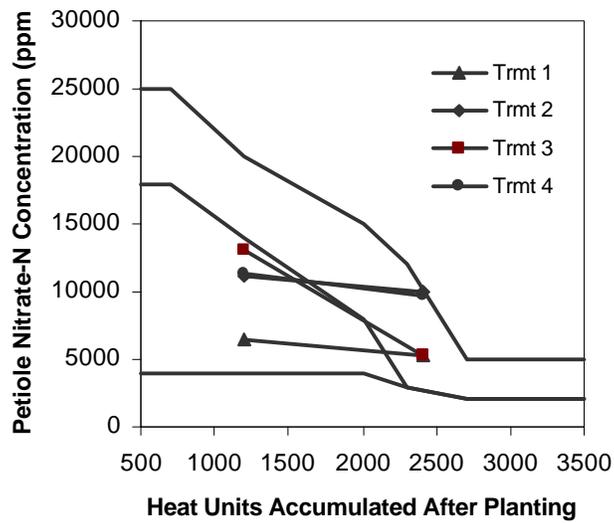


Figure 2. Petiole nitrate-N levels for N-management study, Maricopa, 1999.

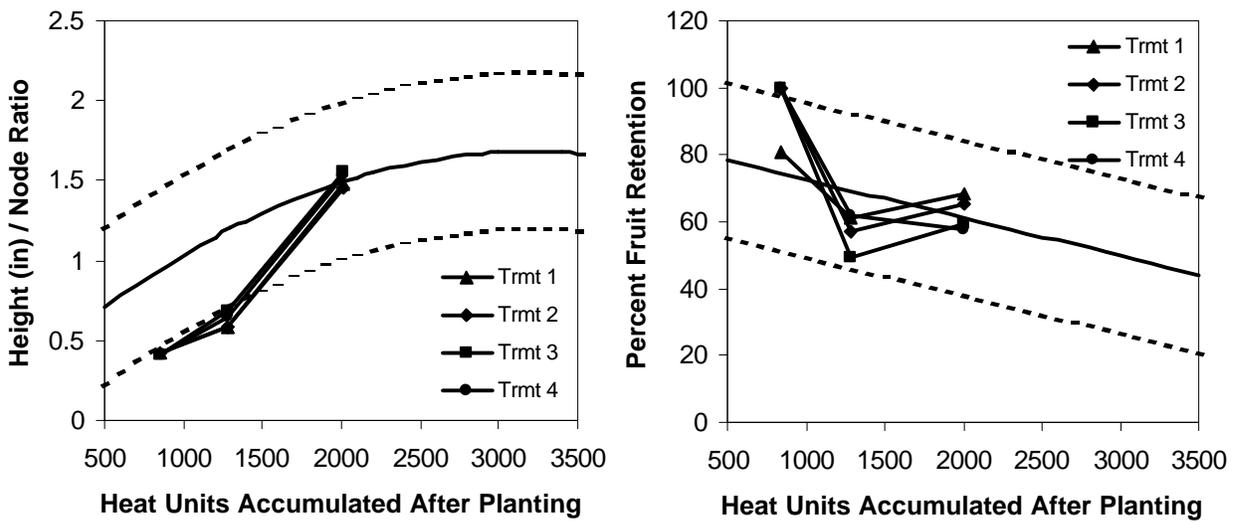


Figure 3. Height to node ratio and fruit retention levels for N-management study, Marana, 1999.

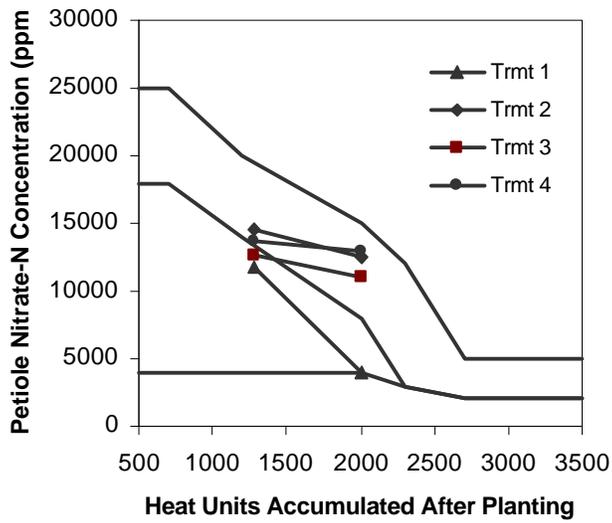


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