Nitrogen Management Experiments For Upland and Pima Cotton, 1997

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Abstract

Two field experiments were conducted in Arizona in 1997 at two locations (Maricopa and Marana). The Maricopa experiment has been conducted for eight consecutive seasons, the Marana site was initiated in 1994. The purposes of the experiments were to validate and refine nitrogen (N) fertilization recommendations for both Upland and Pima 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.

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 preseason 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 these aforementioned tools. Fertilizer N applications based purely on conjecture or guesswork are discouraged. The two field experiments conducted in 1997 serve as an extension of consecutive experiments from 1989 through 1996 (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 and Silvertooth and Norton, 1997) 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 1997 at the University of Arizona Maricopa Agricultural Center (MAC) and the Marana Agricultural Center (MAR).

Both Upland (G. hirsutum L., var. DP 33b) and American Pima (G. barbadense L., var. Pima S-7) were planted on a Casa Grande sandy loam on 13 March at Maricopa. The experimental structure was a split plot within a randomized complete block design with three replications. Whole plots were cotton varieties (DP 33b and Pima S-7), with subplots being N treatments (Table 1). Subplots were eight, 40 inch rows wide and extended the full length of the irrigation run (600 ft.). At Marana, only Upland cotton, STV 474, was planted on 15 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 NO_3^--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. Final irrigations and harvest dates were 18 August and 23 October, at Maricopa and 19 August and 9 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. 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 NO_3^-N concentrations are shown in Fig. 1 and 2 for the DP (NuCOTN) 33b and Pima S-7. Low plant vigor resulted in low HNRs for most of the season for both the Upland (DP 33b) and Pima (S-7) varieties. Fruit retention patterns were generally strong for both varieties all season. With the development of a substantial boll load, which is indicative of a strong N sink and a high N demand, N fertilizer applications were carried out for treatments 3 and 4 on 14 May, 9 June, and 20 June.

Very slight visual symptoms of N deficiency became apparent in check plots for both DP 33b and Pima S-7 in late June (early bloom 1200 to 1500 HUAP). The DP 33b plots for treatment 3 progressed towards cut-out near 5 August (approx. 2700 HUAP), which is consistent with a medium season Upland variety supporting a strong boll load, as this crop was. The final irrigation was applied on 18 August in an effort to provide adequate soil moisture to accomplish full development of bolls set by cut-out. Defoliants were applied on 2 October to all plots.

Plots were mechanically harvested on 23 October. Yield data for both the DP 33b, and Pima S-7 are shown in Table 4. Significant differences were not detected among the N treatments for either variety, even with the check

(treatment 1). The results from previous seasons (Silvertooth et al., 1991; Silvertooth et al., 1992; Silvertooth et al., 1993 and Silvertooth et al., 1994), have generally shown a N response, but no yield benefit in terms of 2X feedback treatment (4), which received a total of 270 lbs. N/acre applied over three applications, or from treatment no. 2, which received a total of 225 lbs. N/acre, split over four applications. Yields were optimized (arithmetically) with treatment no. 3 for the Pima S-7 and treatment no. 4 with 33b. Therefore, one might speculate that some benefit was possibly gained with the DP 33b by providing slightly higher fertilizer N rates, probably with the later applications when the plant was carrying a high FR level and was experiencing low vigor.

Marana

The STV 474 at Marana developed a moderate fruit load early (Figure 3), experienced a small drop in FR near first bloom (~1200 HUAP), but experienced marked improvement in early to peak bloom (approx. 1,500 to 2,000 HUAP). Plant vigor (HNR) patterns were low early in the season but increased to moderate levels near the optimum baseline mid-season. In general, based upon FR and HNR measurements, the crop vegetative/reproductive balance was favorable for most of the fruiting cycle.

Rates of N fertilization ranged from 0 to 200 lbs. N/acre (Table 3). In earlier studies, rates up to 350 lbs. N/acre were used. Based upon results from earlier studies at Marana (Silvertooth and Norton, 1997) a more conservative approach to N fertilization was employed in 1997. With the strong fruit load, all plots progressed into cut-out by about 10 August. The final irrigation was applied on 19 August, which was supplemented by rainfall in late August to accommodate complete development of bolls set through cut-out. Plots were harvested on 9 October. Lint yield results (Table 4) revealed no significant differences among the N fertilization treatments. However, it is interesting to note that the highest rates of N fertilization with treatments no. 4 and 2 (200 and 150 lbs. N/acre, respectively) provided the highest yields (arithmetically).

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Table 1. Nitrogen fertilization treatments used at the Maricopa, and Marana Agricultural Centers, 1989-1997.*

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, 1997.

			N Management Treatment			
Date	**Form**	**Method**	**1**	**2**	**3**	**4**
				lbs. N/acre		
21 March	21-0-0	SD	0	45	0	0
14 May	21-0-0	SD	0	45	45	90
9 June	21-0-0	SD	0	90	45	90
20 June	21-0-0	SD	0	45	45	90
		Total	**0**	**225**	**135**	**270**

Table 3. Fertilizer N applications for each N management treatment, Marana, 1997.

			N Management Treatment			
Date	**Form**	**Method**	**1**	**2**	**3**	**4**
				lbs. N/acre		
16 May	21-0-0	SD*	0	50	0	0
30 May	21-0-0	SD	0	50	50	100
20 June	21-0-0	SD	0	50	50	100
		Total	**0**	**150**	**100**	**200**

*Sidedress

Table 4. Lint yields from Maricopa and Marana N-management studies, 1997.

Treatments	Lint Yield (lbs. lint/acre)
Maricopa	
NuCotn 33B	
4	1501 a*
3	1478 a
2	1475 a
1	1322 a
OSL	0.1915
C.V. (%)	6.66
LSD (α=0.05)	NS
Pims S-7	
3	954 a*
4	888 ab
2	787 ab
1	711 b
OSL	0.0961
C.V. (%)	12.12
LSD (α=0.05)	NS
Marana	
Stoneville STV 474	
4	1137 a*
2	1117 ab
1	1098 ab
3	1078 b
OSL	0.1016
C.V. (%)	2.74
LSD (α=0.05)	NS

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

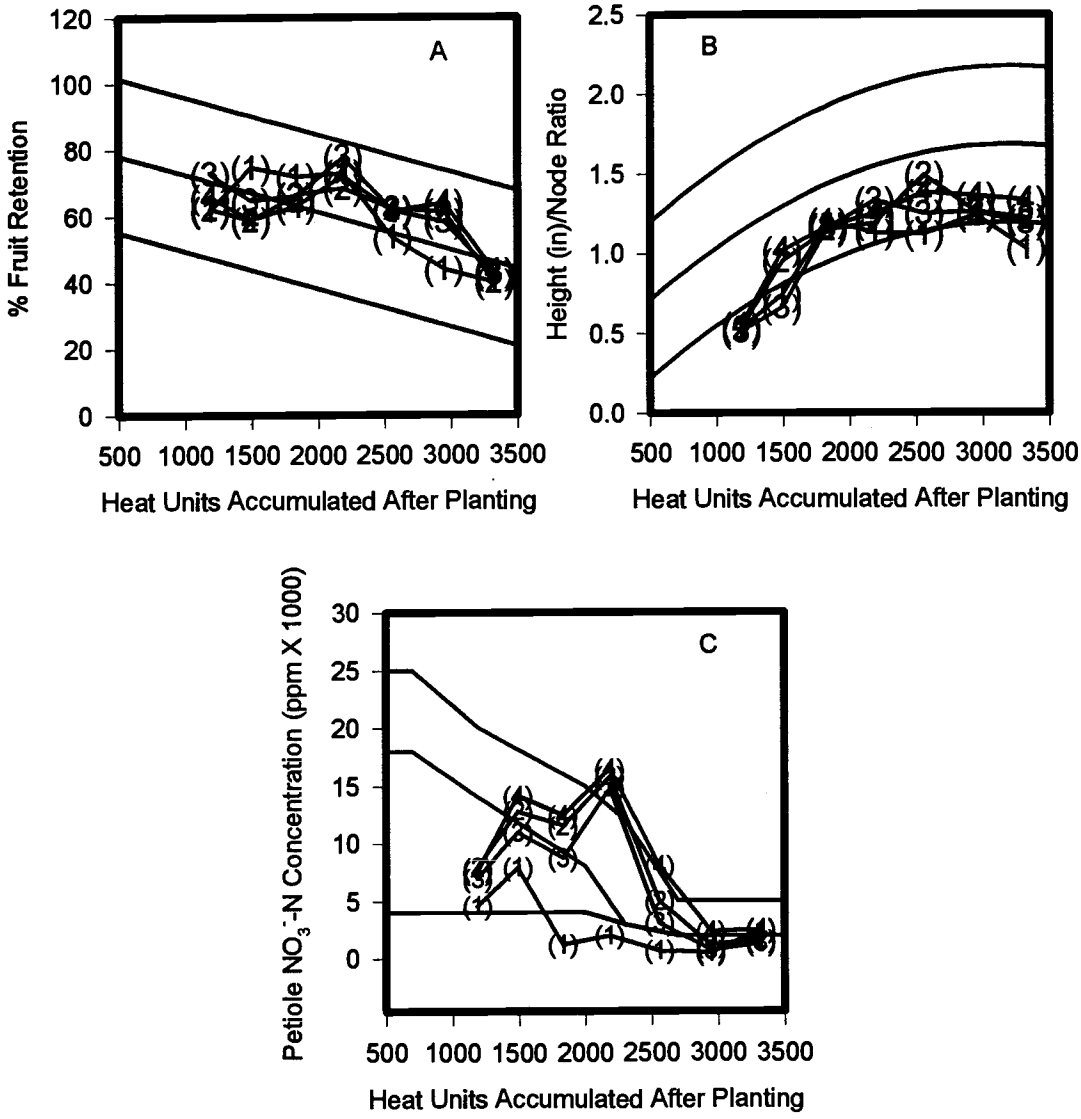

Figure 1. Data summaries for N Management study, Maricopa Ag. Center NuCotn 33B; A) fruit retention B) height to node ratios, and C) petiole nitrate-N concentrations.

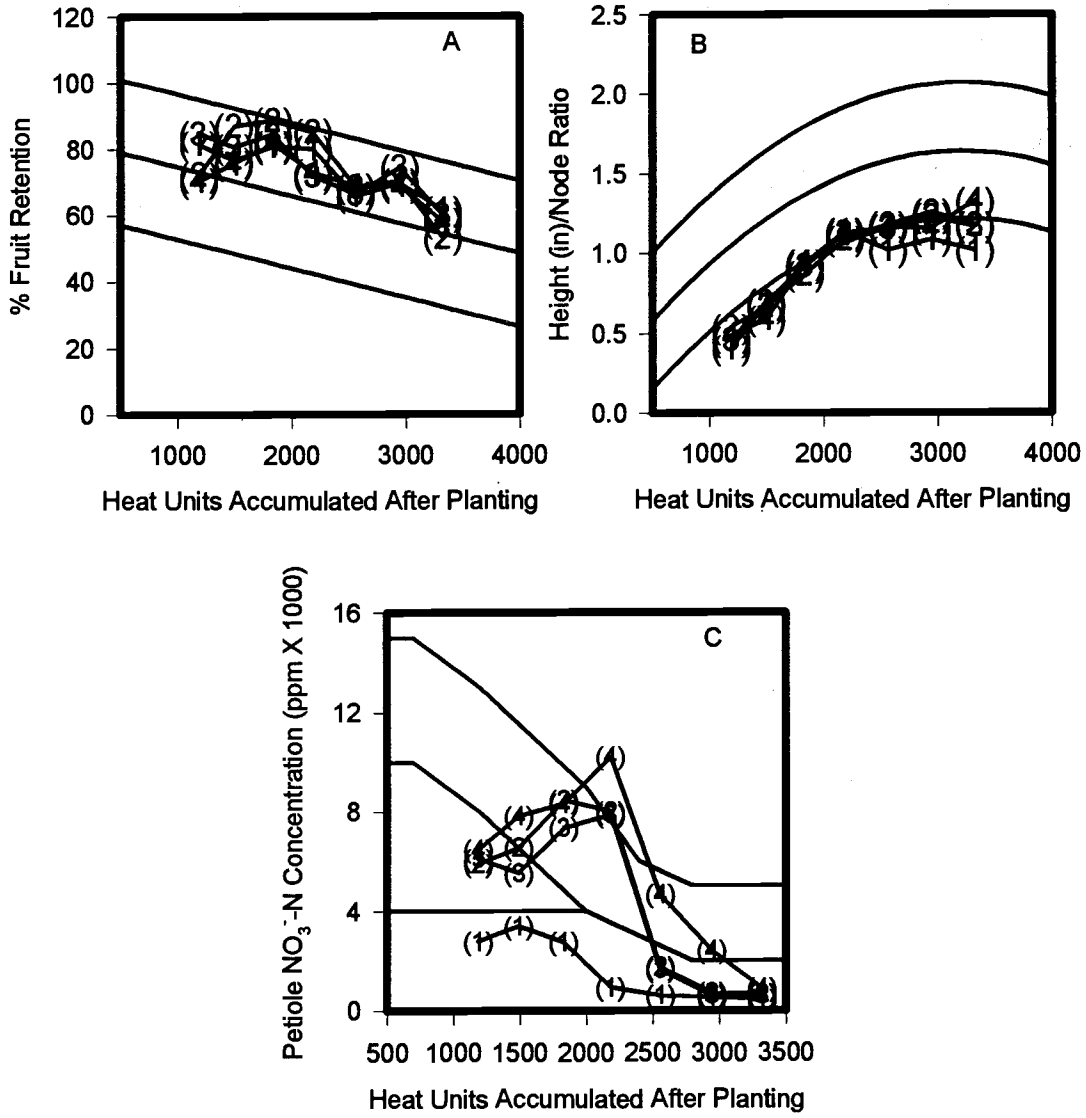

Figure 2. Data summaries for N Management study, Maricopa Ag. Center Pima S-7; A) fruit retention B) height to node ratios, and C) petiole nitrate-N concentrations.