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NITROGEN REGQUIREMENTS IN UNR COTTON SYSTEMS

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Abstract

Field studies were conducted in 1999 and 2000 to evaluate nitrogen fertilizer requirements for ultra narrow row cotton production in Texas. Nitrogen fertilizer rates of 0, 50, 100 and 150 lbs N/acre were applied to UNR row spacings of 15 and 19 inches and a conventional row spacing of 38 inches. Both row spacing and N rate significantly affected plant height. From peak bloom and through maturity, plants were significantly shorter in the UNR treatments compared to conventionally spaced treatments. N fertilizer increased plant height at each growth stage compared to the control, except pinhead square. Plants in conventional rows had significantly greater petiole nitrate concentrations compared to UNR plants across N treatments. UNR row spacing significantly increased lint yield in 1999, but not in 2000 when moisture was very limiting during late bloom and boll fill. Fertilizer N increased cotton lint yields regardless of row spacing in 1999, but no differences were observed among rates from 50 to 150 lbs N/acre. In contrast, fertilizer N did not increase lint yield in 2000.

Introduction

Producer interest in ultra-narrow row (UNR) cotton production systems (i.e., row spacing less than 20-inches) has increased in Texas over the last several years. UNR systems have shown the potential to increase production efficiency compared to conventional (40-inch) and narrow (30-inch) row spacing systems. Research in central Texas has shown that UNR may shorten the crop development period, which can reduce costs associated with late season insect control, and can lessen yield and quality losses that often result from September rainfall. In addition, early crop development has the potential to reduce over-wintering boll weevil populations for the coming year. Most importantly, studies have shown that UNR production systems can increase cotton yields by 40 to 100% compared to conventional and narrow row spacing` systems.

Effective nitrogen management is more important for cotton than for most other major field crops. Nitrogen deficiency during the critical fruiting period from first square to peak flowering (typically 40 to 85 days after planting) can significantly reduce crop yields (Gerik et al., 1997). Likewise, excess N can promote vegetative growth at the expense of boll production, promote shedding of floral buds and small bolls, and delay maturity.

Situation

The basic N requirements of cotton are reasonably well defined. However, no information is available regarding the effects of narrow row spacing on cotton N requirements. UNR production systems may alter N uptake and use efficiencies relative to conventional and narrow row spacings. Shorter growth periods and more effective use of soil N may reduce the amount of fertilizer necessary to supply adequate N during the season. On the other hand, increased water use efficiency and the associated greater yield potential may increase crop N requirements.

Objective

Determine nitrogen fertilizer requirements for optimum growth and yield in ultra narrow row versus conventional row spacing cotton production systems.

Materials and Methods

The study site was located on the Stiles Research and Demonstration Farm near Taylor, Texas. Average annual rainfall for the area is 34 inches and the average frost free period is approximately 224 days. The study was designed as a randomized complete block, arranged as a split plot with four replications. Main plots were row spacing (19 and 38 inches in 1999, 15 and 38 inches in 2000) and subplots (30 by 350 feet) were nitrogen rate (0, 50, 100 and 150 lbs N per acre). Nitrogen fertilizer was applied as 32% solution and was knifed approximately 6 inches deep on 15-inch centers on all plots prior to planting.

In 1999, DP436RR was planted in 38 and 19-inch rows on April 12. UNR plots were planted by making a second pass through each plot with the conventional planter. Final plant populations were 44,800 plants per acre for conventional plots and 91,000 plants per acre for UNR plots. In 2000, DP420RR was planted in 38 and 15-inch rows on April 19. Conventional treatments had a final population of 50,394 plants per acre while the UNR treatment had a population of 106,404 plants per acre.

Prior to fertilizer application each year, soil samples were collected from the 0 nitrogen plots in increments of 0 to 6, 6 to 12, 12 to 24, 24 to 36 and 36 to 48 inches for chemical analysis. Plant height was determined at pinhead square, peak bloom and maturity by measuring 20 plants in each plot. Petiole nitrate concentrations were measured at peak bloom by collecting 20 petioles from each plot. Prior to harvest, plant and boll counts were taken from three locations in each plot to provide estimates of bolls per acre and bolls per plant. Five plants from each plot were mapped to determine node number and fruiting position and retention. Plots were machine harvested on August 31, 1999 and August 29, 2000.

Results and Discussion

Rainfall was below the long-term April-July average of 12.08 inches, with only 84.4% received during the same period for 1999 and 94.7% in 2000. In 1999, dry soil conditions at planting resulted in delayed and staggered emergence; however, the limited rainfall was well distributed and resulted in excellent yields. In 2000, stand establishment was excellent, but the last effective rainfall occurred June 10 resulting in very dry conditions during late bloom and boll fill. Incremental soil samples to a depth of 48 inches indicated moderate residual nitrogen (as nitrate) levels in 1999 and low levels in 2000.

Both row spacing and N rate significantly affected plant height. Plant growth was initially uniform between row spacings as indicated by plant height data at pinhead square (Figure 1). However, by peak bloom and through maturity plants were significantly shorter in the UNR treatments compared to conventionally spaced treatments. N fertilizer increased plant height at each growth stage compared to the control, except pinhead square in 2000 (Table 1). In 1999, differences between N rates were observed only at peak bloom when plant height was greater for the 150 lb N/acre treatment than the 50 lb N/acre. Overall, differences in plant height were much less evident in 1999 than in other years. This was attributed largely to the high degree of vegetative branching which was observed across all treatments. Early season thrips and flea hopper damage was severe and likely contributed to this growth pattern. In 2000, both the 100 and 150 lb N/acre treatments produced greater height than the 50 lb N/acre treatment at peak bloom and maturity.

Both row spacing and N rate significantly affected petiole nitrate concentrations at peak bloom (Table 2). Petiole nitrate concentrations increased consistently with increasing N rate regardless of row spacing. However, plants in conventional rows had significantly greater nitrate concentrations compared to UNR plants across N treatments.

Similarly, both row spacing and N rate significantly affected cotton lint yield in 1999 (Table 3). Averaged across N rates, the 19-inch UNR row spacing significantly increased lint yields producing 1,089 lbs lint/acre compared to 865 lbs lint/acre for conventional 38-inch row spacings. Fertilizer N increased cotton lint yields regardless of row spacing, but no differences were observed among rates from 50 to 150 lbs N/acre. In contrast, yields were much lower in 2000 with no differences among N rates. Further, yields were significantly greater in conventional rows compared to UNR. High plant populations in UNR treatments apparently were much more affected by the limited moisture conditions than plants in conventionally spaced rows.

In both years, boll numbers per acre were greater for UNR spacing treatments compared to conventional row spacing; however, boll size was significantly less for UNR treatments in 2000 (Table 4).

Consistent with previous results, 1999 plant mapping data showed that UNR plants set a higher percentage of bolls on fruiting branches 1 through 5 compared to plants in conventional row spacings (Table 5). Early season insect damage at this site resulted in loss of a high percentage of first position bolls. In addition, increasing N rate tended to shift boll retention to higher positions, regardless of row spacing. In 2000, no differences were observed in boll distribution due to row spacing. N rate had minor effects on micronaire in 1999 and length in 2000, while row spacing did not affect lint quality (Table 6).

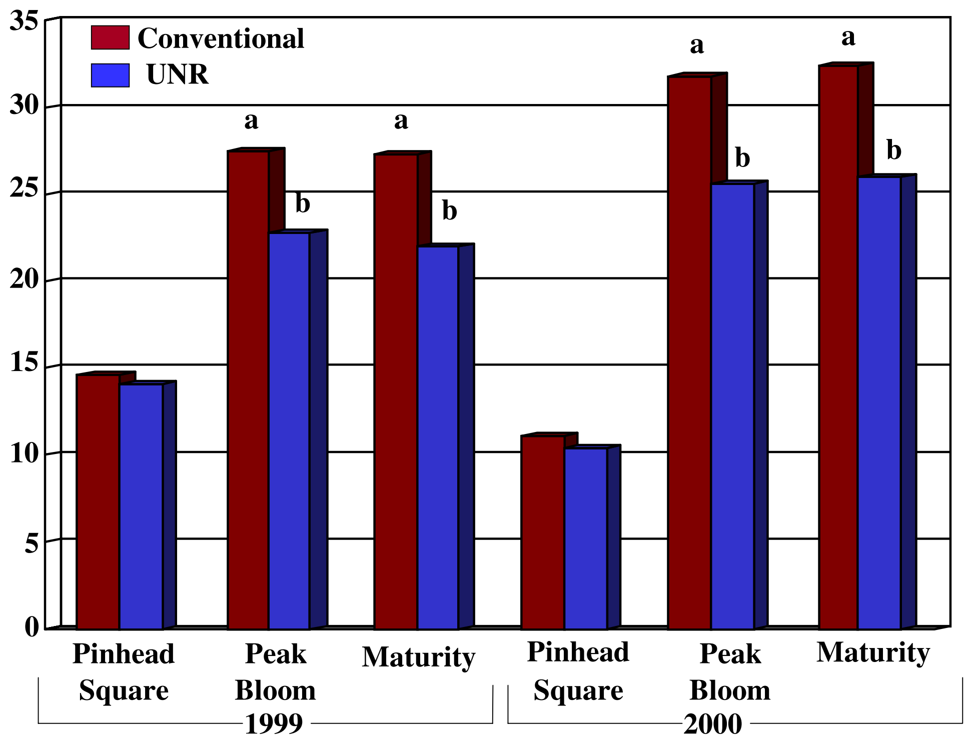

Figure 1. Effects of Row Spacing on Plant Height.

Table 1. Effects of N Rate on Plant Height (inches)

	1999			2000		
N Rate	Pinhead Square	Peak Bloom	Maturity	Pinhead Square	Peak Bloom	Maturity
0	13.1 b	22.9 c	23.0 b	10.6	24.9 c	26.2 c
50	14.9 a	25.4 b	24.9 a	10.7	28.4 b	29.0 b
100	15.4 a	25.7 ab	25.4 a	11.2	30.3 a	30.5 a
150	14.1 ab	26.6 a	25.2 a	10.6	31.1 a	31.0 a
LSD (0.05)	1.4	1.0	1.4	---	1.2	1.4

Table 2. Effects of Row Spacing and N Rate on Petiole Nitrate Levels (ppm) in 1999 and 2000

N Rate	Conv.	UNR	Average
0	1,027	258	643 d
50	2,580	1,202	1,891 c
100	4,207	3,045	3,626 b
150	5,685	4,372	5,029 a
LSD (0.05) = 448	3,375 a	2,219 b	LSD (0.05) = 584

Table 3. Effects of Row Spacing and N Rate on Cotton Lint Yields (lbs/acre)						
	1999			2000		
N Rate	Conv.	UNR	Average	Conv.	UNR	Average
0	804	1,038	921 b	520	457	489
50	889	1,123	1,006 a	480	426	453
100	880	1,081	981 a	489	339	414
150	886	1,115	1,001 a	516	347	432
Average	865 b	1,089 a	LSD (0.05) = 51	501 a	392 b	
	LSD (0.05) = 64			LSD (0.05) = 69		

Table 4. Effects of Row Spacing on Bolls per Acre and Lint per Boll				
	1999		2000	
Row Spacing (in)	Bolls/Acre	Lint/Boll (g)	Bolls/Acre	Lint/Boll (g)
Conventional	275,292 b	1.43	198,386 b	1.15 a
UNR	350,958 a	1.41	217,688 a	0.81 b
LSD (0.05)	43,330	---	19,182	0.12

Table 5. Effects of Row Spacing and N Rate on Boll Distribution (%) by Fruiting Branches					
N Rate (lbs/A)	1999			2000	
	1 to 5		6 to 10	1 to 5	6 to 10
	Conv.	UNR	Average	Average	Average
0	41.6	43.6	37.2	80.8	2.8
50	45.9	46.1	42.2	78.4	8.2
100	35.8	40.3	45.2	70.5	25.2
150	36.2	40.7	42.2	79.7	16.7
LSD (0.05) = 2.3	39.8 b	42.7 a			

Table 6. Effects of Nitrogen Rate on Fiber Quality parameters – 1999 and 2000						
N Rate (lbs/acre)	Micronaire		Length (in)		Strength (g/tex)	
	1999	2000	1999	2000	1999	2000
0	3.69 a	3.24	1.095	0.974 a	27.1	21.2
50	3.61 ab	3.34	1.086	0.946 b	27.4	20.9
100	3.45 b	3.40	1.083	0.944 b	27.8	20.4
150	3.58 ab	3.38	1.069	0.946 b	27.6	21.0
LSD (0.05)	0.16			0.024		