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DETERMINING THE CORRECT NITROGEN RATE FOR COTTON IN A COTTON/ SOYBEAN ROTATION

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Abstract

The effect of nitrogen fertilization on cotton lint yields and fiber quality parameters in a cotton/soybean rotation was studied on two soil types. Cotton lint yields were increased with nitrogen fertilization on a clay soil, while yields were unaffected on a silt-loam soil. Increasing nitrogen rates produced longer, stronger, more uniform fibers at the clay soil site. Increasing nitrogen rates generally produced lint with higher micronaire readings at the silt-loam site. At the clay soil site the 135 lbs N/a rate produced the greatest returns to producers of $575/acre. This is an increase of $324 over the untreated check. At the silt-loam site the 110 lbs N/a rate produced the greatest returns to producers of $435/acre. This is an increase of $13 over the untreated check.

Introduction

Cotton requires supplemental nitrogen fertilization to achieve maximum lint yields. Proper N rates are critical as lower rates may limit yields while higher rates promote excessive vegetative growth. This delays the harvest and reduces fiber quality. Higher than optimal N rates may also contribute to increased disease and insect pressure. Optimizing N rates also reduces environmental impacts by limiting the potential for run off or leaching. Studies at the University of Missouri-Delta Center have shown that our current soil test recommendations are valid for continuous cotton cultivation. University of Missouri soil test recommendations suggest lowering the N rate by 20-30 lbs/a N following soybeans. Cotton producers have raised concerns about the relevance of these N recommendations for cotton following soybeans.

Methods and Materials

A cotton study was conducted on two cotton fields at the University of Missouri-Delta Center Lee Farm (36°N, 89°W) in Pemiscot County, Missouri in 2003. This evaluation was conducted on both a Tiptonville silt loam soil (Typic Argiudoll, fine-silty, mixed, thermic) and a Sharkey clay soil (very fine, montmorillonite, thermic Vertic Haplaquept). The five nitrogen treatments that were evaluated are listed in Table 1. Soil samples collected before planting indicated that P, K, and pH levels were optimum for producing irrigated cotton. The soil test recommendation for nitrogen at both locations was 110 lbs N/a. With soybeans as the previous crop this rate could be reduced by 25 lbs to a rate of 85 lbs N/a. A pre-plant rate of 60 lbs N/a as UAN 32% was applied to all plots except the untreated check using a four row liquid applicator. At pinhead square the remainder of the nitrogen, as ammonium nitrate, was applied by hand. Each plot was harvested and the lint yield measured. The cotton produced was ginned and the gin turnout calculated. The lint was then analyzed for the fiber quality properties: micronaire, length, strength, and trash percentage. These fiber quality properties were determined at the International Textile Research Center in Lubbock Texas using high volume instrument analysis.

Statistical analyses of the data were preformed with SAS (1990) using General Linear Modeling procedures. Fisher's Protected Least Significant Difference (LSD) was calculated at the 0.05 probability level for making treatment mean comparisons. Regression and correlation analysis were performed in accordance with procedures outlined by the SAS Institute (SAS, 1997). Returns to producers were calculated by using Commodity Credit Corporation Cotton loan rates for 2003 crop White Upland Cotton warehoused in Missouri. Discounts or premiums for fiber properties were applied to the base rate. Input costs for nitrogen were computed at a rate of $0.24 per lbs of N and an application cost of $5.00 per acre. Returns for cottonseed were calculated using a price of $110.00 per ton.

Results and Discussion

The clay soil and the silt-loam sites responded differently to N fertilization in 2003. Nitrogen fertilization significantly increased lint yields at the clay soil site (Table 2). Yields for the recommended rate and the higher rate were statistically equivalent. This supports the current University of Missouri soil test recommendations. However the highest rate of N produced the numerically highest yields. Based on lint yields alone, a reduction of N rates following soybeans on clay soils would not be warranted. There was no significant response to N fertilization at the silt-loam site. This would indicate that the previous soybean crop had supplied sufficient N to maximize cotton lint production. Here the soil test recommended rate produced the numerically highest lint yields. In terms of fiber properties increasing nitrogen rates at the clay soil site produced longer, stronger and more uniform fibers with higher micronaire readings (Table 3). Increasing nitrogen rates reduced turn out. At the silt-loam site increasing N rates generally increased micronaire readings, had a mixed effect on length, and no effect on fiber strength or uniformity (Table 4). Gin turn out was highest for the zero nitrogen rate at the silt-loam site. Tables 4 and 5 show total returns to producers. At the clay soil site lint yields for the soil test recommended N and the Soil test plus 25 lbs were statistically equivalent. However, differences in the fiber properties length and uniformity resulted in higher returns to producers. Net returns to producers indicate that N fertilization above the soil test recommended rate was profitable. At the silt-loam site increasing N fertilization and application costs resulted in mostly negative returns for nitrogen expenditures. In Missouri the cultural practice is for the gin to retain the cottonseed as payment for the ginning process. Larger amounts of cottonseed associated with lower gin turnouts do have a value. This value, while not available to Missouri cotton producers, is calculated in Tables 6 and 7. At the clay soil site the larger amount of seed obtained with increasing N added value to the crop. The writers speculate that increasing N rates produced seed that was higher in protein content. Presently cottonseed is not sold for a premium based on protein. In the future a premium may be added for higher protein levels. At the silt-loam site gin turn out was not increased by N fertilization and total value of the crop was negatively affected.

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Table 1. Nitrogen rates used in 2003 evaluation.

Treatment #	N rate	Lbs N/acre
1	Untreated check	0
2	Soil test recommended minus 50	60
3	Soil test recommended minus 25	85
4	Soil test recommended	110
5	Soil test recommended plus 25	135

Table 2. Average cotton lint yields, gin turnout, and cotton fiber properties on clay soil for N treatments in 2003.

N Treatment	Cottonlint yields (lbs/acre)	Turn out %	Micronaire	Length	Strength	Uniformity
0	491 d	0.4 ab	4.63c	1.047b	27.90b	82.30c
60	750 c	0.41a	4.67bc	1.047b	28.45ab	82.88bc
85	956 b	0.4 ab	4.88ab	1.08 a	28.83ab	83.55ab
110	1059a	0.39bc	4.90a	1.082a	28.97ab	83.88a
135	1098a	0.38c	4.95a	1.09a	29.63a	83.52ab
LSD 0.05	94	0.014	0.21	0.03	1.29	0.89
CV %	7.1	2.3	2.8	1.7	2.9	0.7

Numbers followed by the same letter in each column are not significantly different at the alpha = 0.05 level.

Table 3. Average cotton lint yields, gin turnout, and cotton fiber properties on silt-loam for N treatments in 2003.

N Treatment	Cotton lint yields (lbs/acre)	Turn out %	Micronaire	Length	Strength	Uniformity
0	761a	0.38a	4.68a	1.095bc	28.58a	82.95a
60	680a	0.36b	4.47ab	1.113a	29.07a	83.17a
85	721a	0.36b	4.23ab	1.110ab	28.70a	83.23a
110	870a	0.36ab	4.50ab	1.080c	28.85a	82.82a
135	764a	0.36b	4.18a	1.095bc	29.15a	83.05a
LSD 0.05	244	0.0019	0.45	0.016	1.072	0.94
CV %	20.4	3.4	6.5	0.9	0.7	0.6

Numbers followed by the same letter in each column are not significantly different at the alpha = 0.05 level.

Table 4. Returns to producers based on fiber quality for N treatments on clay soil, 2003.

N Treatment	Yield lbs/acre	Penalty or premium (basis points) Length	Strength	Uniformity	Price $/lbs	Gross Return	N cost	Application cost	Net returns to Producers
0	491	-0.0115	0.0000	0.0000	0.512	$251.39	$0.00	$0.00	$251.39
60	750	-0.0115	0.0000	0.0000	0.512	$384.00	$14.40	$5.00	$364.60
85	956	0.0180	0.0000	0.0025	0.544	$520.06	$20.40	$10.00	$489.66
110	1059	0.0180	0.0000	0.0025	0.544	$576.10	$26.40	$10.00	$539.70
135	1098	0.0325	0.0035	0.0025	0.562	$617.08	$32.40	$10.00	$574.68

Table 5. Returns to producers based on fiber quality for N treatments on silt-loam soil, 2003.

N Treatment	Yield lbs/acre	Penalty or premium (basis points) Length	Strength	Uniformity	Price $/lbs	Gross Return	N cost	Application cost	Net returns to Producers
0	761	0.0325	0.0000	0.0000	0.556	$423.12	$0.00	$0.00	$423.12
60	680	0.0325	0.0000	0.0025	0.5585	$379.78	$14.40	$5.00	$360.38
85	721	0.0325	0.0000	0.0025	0.5585	$402.68	$20.40	$10.00	$372.28
110	870	0.0180	0.0000	0.0000	0.5415	$471.11	$26.40	$10.00	$434.71
135	764	0.0325	0.0000	0.0025	0.5585	$426.69	$32.40	$10.00	$384.29

Table 6. Total returns, lint plus seed, to cotton industry for N treatments on clay soil, 2003. Value of crop due to N fertilization is also presented.

N Treatment	Lbs Seed	Seed Value	Lint Value	Total Value	Added Value of N
0	737	$40.51	$251.39	$291.90	$0.00
60	1079	$59.36	$364.60	$423.96	$132.06
85	1434	$78.87	$489.66	$568.53	$276.63
110	1656	$91.10	$539.70	$630.80	$338.90
135	1791	$98.53	$574.68	$673.21	$381.31

Table 7. Total returns, lint plus seed, to cotton industry for N treatments on silt-loam soil, 2003. Value of crop due to N fertilization is also presented.

N Treatment	Lbs Seed	Seed Value	Lint Value	Total Value	Added Value of N
0	1242	$68.29	$423.12	$491.41	$0.00
60	1209	$66.49	$360.38	$426.87	-$64.54
85	1282	$70.50	$372.28	$442.78	-$48.63
110	1547	$85.07	$434.71	$519.77	$28.37
135	1358	$74.70	$384.29	$459.00	-$32.41