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DO WE NEED TO ADJUST NITROGEN RATES FOR COTTON IN A COTTON/SOYBEAN ROTATION?

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Abstract

In a two-year study the effect of nitrogen fertilization on cotton lint yields and fiber quality in a cotton/soybean rotation was studied on two soil types. In both years 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 in 2003. Increasing nitrogen rates generally produced lint with higher micronaire readings at the silt-loam site both years. At the clay soil site the 135 lbs N/a rate produced the greatest returns to producers both years. The two-year average net returns were $293.00 greater than the untreated check. At the silt-loam site the 110 lbs N/a rate produced the greatest two-year average greatest net returns. Based on this study a reduction in N rates following soybeans on a clay soil would not be justified. However, on silt loam soils the N rate may be reduced following soybeans.

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^{o}N, 89^{o}W) in Pemiscot County, Missouri in 2003 and 2004. 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 seed 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 for both years were calculated by using Commodity Credit Corporation Cotton loan rates for 2004 crop 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 both years. 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 each year. 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 during either year. This would indicate that the previous soybean crop had supplied sufficient N to maximize cotton lint production. In 2003 the soil test recommended rate (110 lbs N/a) produced the numerically greatest lint yields. In 2004 the 85 lbs N/a rate produced the numerically greatest 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) in 2003. The only fiber property to by affected by N rate was micronaire, with all N applications producing reading significantly greater than the untreated check. In 2003 increasing nitrogen rates reduced turn out. In 2004 significant differences were found for gin turn out. These differences were not correlated to N application rate. In 2003 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 3). In 2004 no significant differences between N treatments were found for these fiber properties. Gin turn out was highest for the zero nitrogen rate at the silt-loam site in both years. Tables 6 and 7 show total returns to producers. At the clay soil site lint yields and net returns for the soil test recommended N and the soil test plus 25 lbs were statistically equivalent. However, the higher N rate produced numerically greater returns each year. Net returns to producers indicate that N fertilization above the soil test recommended rate was profitable. The two-year average value added by N fertilization was greatest for the 110 lbs N/a rate. 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 4 and 5. 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 net returns were statistical equivalent for all treatments including the untreated check. The two-year average valued added by N fertilization was negative for all treatments except the 100 lbs N/a rate. At the silt-loam site gin turn out was not increased by N fertilization and total value of the crop was negatively affected.

Acknowledgements

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Table 1. Nitrogen rates used in 2003 and 2004 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	Cotton lint yields (lbs/acre)		Turn out %		Micronaire		Length		Strength		Uniformity	
	2003	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**
0	491d	315d	40ab	41ab	4.63c	4.05b	1.047b	1.047a	27.90b	26.00a	82.30c	82.52a
60	750c	633c	41a	41ab	4.67bc	4.50a	1.047b	1.035a	28.45ab	26.38a	82.88bc	82.95a
85	956b	761b	40ab	42a	4.88ab	4.57a	1.08a	1.043a	28.83ab	26.10a	83.55ab	82.30a
110	1059a	923a	39bc	43a	4.90a	4.53a	1.082a	1.050a	28.97ab	26.12a	83.88a	82.75a
135	1098a	934a	38c	40b	4.95a	4.55a	1.09a	1.047a	29.63a	25.67a	83.52ab	82.75a
LSD 0.05	94	100	1.4	1.9	0.21	0.16	0.03	0.017	1.29	0.74	0.89	0.75
CV %	7.1	9.1	2.3	3.0	2.8	2.4	1.7	1.1	2.9	1.8	0.7	0.6

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 and 2004.

N Treatment	Cotton lint yields (lbs/acre)		Turn out %		Micronaire		Length		Strength		Uniformity	
	2003	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**
0	761a	825a	38a	39a	4.68a	4.80a	1.095bc	1.070a	28.58a	26.08a	82.95a	83.05a
60	680a	817a	36b	37ab	4.47ab	4.68a	1.113a	1.067a	29.07a	25.13a	83.17a	82.95a
85	721a	979a	36b	38ab	4.23ab	4.57a	1.110ab	1.082a	28.70a	25.75a	83.23a	83.20a
110	870a	942a	36ab	36b	4.50ab	4.78a	1.080c	1.070a	28.85a	25.22a	82.82a	82.90a
135	764a	940a	36b	37b	4.18a	4.63a	1.095bc	1.080a	29.15a	25.67a	83.05a	83.23a
LSD 0.05	244	243	1.9	2.0	0.45	0.21	0.016	0.023	1.072	0.97	0.94	0.84
CV %	20.4	17.5	3.4	3.5	6.5	2.9	0.9	0.7	0.7	11.6	0.6	0.7

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

Table 4. Pounds of lint & seed, lint price, and gross returns to producers from nitrogen treatments, on clay soil 2003 and 2004.

N Treatment	Lint (lbs/a)		Seed (lbs/a)		Lint price ($/lbs)		Gross return: lint ($/a)		Gross return: seed ($/a)		Total gross return ($/a)	
	2003	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**
0	491d	315d	737e	482d	0.529ab	0.529a	259d	166d	41e	27d	300d	193d
60	750c	633c	1093d	850c	0.508b	0.502b	378c	318c	60d	47c	438c	365c
85	956b	761b	1452c	1066b	0.558a	0.500b	533b	381b	80c	59b	613b	440b
110	1059a	923a	1677b	1342a	0.546a	0.510ab	578ab	470a	92b	74a	670ab	544a
135	1098a	934a	1830a	1330a	0.549a	0.523a	603a	492a	101a	73a	704a	565a
LSD 0.05	94	100	151	135	0.032	0.019	59	54	8	7	66	61
CV %	7.1	9.1	7.2	8.6	3.9	2.5	8.1	9.7	7.2	8.6	7.8	9.4

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

Table 5. Pounds of lint & seed, lint price, and gross returns to producers from nitrogen treatments, on silt-loam soil 2003 and 2004.

N Treatment	Lint (lbs/a)		Seed (lbs/a)		Lint price ($/lbs)		Gross return: lint ($/a)		Gross return: seed ($/a)		Total gross return ($/a)	
	2003	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**	**2003**	**2004**
0	761a	825a	1246a	1267a	0.555a	0.490a	421a	404a	68a	71a	490a	475a
60	680a	817a	1221a	1374a	0.568a	0.489a	386a	402a	67a	76a	453a	477a
85	721a	979a	1298a	1628a	0.567a	0.473a	409a	462a	71a	90a	480a	552a
110	870a	942a	1534a	1635a	0.556a	0.469a	484a	442a	84a	89a	568a	532a
135	764a	940a	1378a	1612a	0.563a	0.481a	430a	453a	75a	89a	505a	542a
LSD 0.05	244	243	359	338	0.014	0.025	133	131	20	19	153	149
CV %	20.4	17.5	17.0	14.6	1.6	3.4	19.9	14.6	17.1	14.6	19.4	18.8

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

Table 6. N costs, total net returns and value added by N fertilization on clay soil 2003 and 2004.

N Treatment	N cost ($/a)	Total net returns ($/a)		Value added by N fertilization ($/a)		
		2003	**2004**	**2003**	**2004**	**Average**
0	0	300d	193d	0	0	0
60	19.4	419c	346c	119	153	136
85	30.40	583b	410b	238	110	197
110	36.40	634ab	508a	334	208	271
135	42.40	662a	523a	322	223	293
LSD 0.05	NA	66	61	NA	NA	NA
CV %	NA	8.2	10.1	NA	NA	NA

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

Table 7. N costs, total net returns and value added by N fertilization on silt-loam soil 2003 and 2004

N Treatment	N cost ($/a)	Total net returns ($/a)		Value added by N fertilization ($/a)		
		2003	**2004**	**2003**	**2004**	**Average**
0	0	490a	475a	0	0	0
60	19.4	434a	485a	-56	10	-23
85	30.40	450a	521a	-40	31	-5
110	36.40	532a	496a	42	6	24
135	42.40	464a	499a	-26	9	-9
LSD 0.05	NA	153	149	NA	NA	NA
CV %	NA	20.5	19.7	NA	NA	NA

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