COTTON RESPONSE TO THE SOURCE AND TIMING OF NITROGEN FERTILIZATION ON A SANDY COASTAL PLAIN SOIL

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Abstract

Field studies were conducted during 1995-1997 to evaluate cotton (*Gossypium hirsutum*) response to the source, and timing of N fertilizer applications. The test was conducted on an irrigated Lucy loamy sand (Arenic Kandiudults). Treatments included N sources, timing of N application (ammonium nitrate) and split applications of N (ammonium nitrate & ammonium sulfate). Nitrogen sources applied preplant included: 1) ammonium nitrate (34-0-0), 2) ammonium sulfate (21-0-0-24.2), 3) urea (46-0-0), 4) urea-ammonium nitrate solution (UAN; 32-0-0), 5) UAN + ammonium thiosulfate (28-0-0-5). The non-sulfur containing sources were applied with and without S. For these treatments, S at a rate of 40 lb/acre was applied preplant as gypsum. Times of application for ammonium nitrate were preplant, first true leaf, first square and first bloom. Split applications of ammonium nitrate and ammonium sulfate were made by applying half of the N preplant and the remaining N at first square. Two additional treatments received split applications (preplant/first square) of N as a 50:50 mixture of ammonium sulfate with urea or ammonium nitrate. To evaluate the effects of supplemental applications of K on cotton yield, ammonium sulfate was applied in combination with 60 lb K_2O/acre. These treatments were applied as a two-way (preplant/first square) or three-way (preplant/first square/first bloom) split. All N sources were applied at a rate to supply 90 lb N/acre. Statistical analysis of the data showed some minor differences among sources, but overall the results of this three-year study show that there were no superior N sources since the sources tested produced similar lint yields. For ammonium nitrate, preplant applications of N were sufficient in two out of three years. Likewise, split applications (half preplant and half at first square) of ammonium nitrate did not improve yields as compared to applying all of N preplant. Data from the non-sulfur containing sources that received supplemental S as gypsum suggests that both the N and S fertility requirements need to be considered when producing cotton on coastal plain soils. Applying ammonium sulfate with supplemental K did not improve yields as compared to ammonium sulfate or ammonium nitrate. Likewise, a 50:50 mixture of ammonium sulfate and ammonium nitrate or urea split applied (half at planting and half at first square) did not improve yields as compared to ammonium sulfate or ammonium nitrate applied alone. Lint quality was not affected consistently by any of the N fertility treatments.

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Introduction

Cotton acreage has increased in the coastal plain of South Alabama in recent years. Maintenance of a current and adequate data base for the purpose of making N fertilizer recommendations is needed. In this test a modern cotton cultivar was evaluated for its response to the source of N fertilizer. A three-year field test was conducted to evaluate the need for N fertilization on a deep sandy coastal plain soil.

This field study was initiated in 1995 on a Coastal Plain soil in south Alabama. The objectives of the study were: 1) Determine cotton yield response to the source of N on a sandy soil in south Alabama; 2) Evaluate cotton response to the timing and split applications of N fertilizer; and 3) Determine the effect of applied N on cotton fiber quality.

Materials and Methods

The study was conducted during 1995-1997 on a Lucy loamy sand (loamy, kaolinitic, thermic Arenic Kandiudults) in south Alabama. Treatments (Table 1) included N sources, timing of N application (ammonium nitrate) and split applications of N (ammonium nitrate & ammonium sulfate). Nitrogen sources applied preplant included: 1) ammonium nitrate (34-0-0), 2) ammonium sulfate (21-0-0-24.2), 3) urea (46-0-0), 4) urea-ammonium nitrate solution (UAN; 32-0-0), 5) UAN + ammonium thiosulfate (28-0-0-5). The non-sulfur containing sources were applied with and without S. For these treatments, S at a rate of 40 lb/acre was applied preplant as gypsum. Times of application for ammonium nitrate included preplant, first true leaf, first square and first bloom. Split applications of ammonium nitrate and ammonium sulfate were made by applying half of the N preplant and the remaining N at first square. Two additional treatments received split applications (preplant/first square) of N as a 50:50 mixture of ammonium sulfate with urea or ammonium nitrate. To evaluate the effects of supplemental applictions of K on cotton yield, ammonium sulfate was applied in combination with 60 lb K_2O/acre. These treatments were applied as a two-way (preplant/first square) or three-way (preplant/first square/first bloom) split. The basic N rate for all treatments was 90 lb N/acre. 'Stoneville LA887' was grown in 1995 and 1996, while 'Bollgard 35B' was grown in 1997. Plots were 30 feet long with eight rows. The test was irrigated on an as needed basis using a center pivot irrigation system.

The experiment had a randomized complete block design with four replications. Yields were determined each year by mechanically picking the two center rows from each plot. Lint quality was evaluated using HVI. Surface soil samples were collected in the fall for the determination of soil pH.

Results and Discussion

Excellent lint yields were obtained during the three years of this test (Table 2). Lower yields in 1995 are attributed to hurricane Opal. Just prior to the application of a defoliant and the harvest of seed cotton in 1995, the southern half of Alabama was hit hard by hurricane Opal. After the hurricane we estimated that one-third to one-half of a bale of lint/acre was blown off onto the ground. The source of N had no effect on lint yields in either 1996 or 1997 (Table 2). In 1996, ammonium sulfate produced slightly higher yields compared to ammonium nitrate, UAN and UAN + ammonium thiosulfate. Thus, we conclude that under these growing (environmental) conditions there were no differences among the five sources tested. Soil pH data (data not shown) revealed that ammonium sulfate reduced soil pH approximately 0.2 units as compared to ammonium nitrate and urea.

Recent findings suggest that cotton produced on sandy coastal plain soils may need extra S to optimize yields (Mullins, 1998). Thus, for ammonium nitrate, urea, and UAN extra treatments were incorporated (Table 1) to determine if S was limiting yields on this coastal plain soil. Statistical analysis of the data to evaluate the effects of applying S showed that the addition of S did not affect lint yields in 1996 (Table 3). In 1995, extra S led to a general decrease in yield with the reduction being significant for UAN. In 1997, the addition of S led to an increase in yield. The largest increase was observed with UAN. These data show that both the N and S fertility requirements need to be considered with producing cotton on coastal plain soils.

A potential management decision for N fertilization of coastal plain soils is in regards to the timing of N application. For example, should all of the N be applied at planting or can a producer delay application until after the crop is up. Or, due to potential leaching losses of N on these sandy soils, should the N be split and applied in two or more applications. Timing of application was evaluated using ammonium nitrate (Table 4). In 1995 and 1997, timing of ammonium nitrate application had no effect on lint yields. For 1997, there was a trend for higher yields when the N was applied preplant. In 1996, higher yields were obtained when N application was delayed until first square. This three-year data set (Table 4) suggests that preplant applications of N should be sufficient for cotton produced under similar production systems (growing conditions).

Effects of split applications of N were evaluated using ammonium nitrate and ammonium sulfate (Table 5). In these treatments all of the N was applied preplant or split applied with half of the N applied at planting and the remaining N applied at first square. Statistical analysis of the data showed that split applications of ammonium nitrate did not increase lint yields as compared to applying all of the ammonium nitrate preplant during either year of the test. For ammonium sulfate (Table 5), split applications of N resulted in higher yields in 1995, lower yields in 1996 and no differences in 1997.

Additional treatments were included to evaluate mixtures of ammonium sulfate with urea or ammonium nitrate (Table 6) and to evaluate the effects of supplemental applications of K (Table 7). Statistical analysis of these data showed that 50:50 mixtures of ammonium sulfate with urea or ammonium nitrate did not improve lint yields as compared to applying ammonium sulfate alone. This soil had a medium-high soil test rating for K and each year K was applied to all plots according to soil test recommendations (Adams et al., 1996). Statistical analysis of data from these treatments (Table 7) showed that supplementing ammonium sulfate with a total of 60 lb K_2O/acre (split applied) extra K did not improve yields as compared to ammonium sulfate applied alone.

Lint quality was evaluated during all three years of the test (data not shown). Statistical analysis of the lint quality data showed that N treatments had no consistent effects on lint quality during the three years of this test.

References

Mullins, G.L. 1998. Cotton response to the rate and source of sulfur on a sandy coastal plain soil. J. Prod. Agric. 11:214-218.

Adams, J.F., C.C. Mitchell, and H.H. Bryant. 1994. Soil test fertilizer recommendations for Alabama Crops. Alabama Agric. Exp. Stn. Circ. 178.

Table 1. Treatments applied in 1995-1997 at the Wiregrass Substation to evaluate the effect of the source and timing of N fertilizer on cotton yields.

Trt. No.	Nitrogen Source†	Time of Application
1	UAN Solution (32%)	Preplant
2	UAN Solution (32%) + Sulfur	Preplant
3	28-0-0-5 (UAN + Ammonium thiosulfate)	Preplant
4	Urea	Preplant
5	Urea + Sulfur	Preplant
6	Ammonium Nitrate	Preplant
7	Ammonium Nitrate + Sulfur	Preplant
8	Ammonium Nitrate + Sulfur	First True Leaf
9	Ammonium Nitrate + Sulfur	First Square
10	Ammonium Nitrate + Sulfur	First Bloom
11	Ammonium Nitrate	Preplant/First Square
12	Ammonium Nitrate + Sulfur	Preplant/First Square
13	Ammonium Sulfate	Preplant
14	Ammonium Sulfate	Preplant/First Square
15	Ammonium Sulfate/Urea (50:50 mix)	Preplant/First Square
16	Ammonium Sulfate/ Ammonium nitrate (50:50 mix)	Preplant/First Square
17	Ammonium Sulfate + 60 lb K_2O/acre	Preplant/First Square
18	Ammonium Sulfate + 60 lb K_2O/acre	Preplant/First Square/First Bloom

† Sources receiving additional sulfur (Ammonium nitrate, urea, UAN) received a preplant application of 40 lb S/acre as gypsum.

Table 2. Effect of N sources on mean lint yields. For ammonium nitrate, urea and UAN, only those treatments receiving additional S as gypsum were included. Probabilities are based on contrasts to compare ammonium sulfate with other sources.

Source	Lint Yields 1995	1996	1997
	------------ lbs/acre ------------		
Ammonium Sulfate	819	1389	1426
Ammonium Nitrate	881	1222	1520
Urea	822	1317	1361
UAN	807	1169	1618
UAN + Ammonium Thiosulfate	735	1127	1488
Probability	NS	0.10	NS

Table 3. Effect of applying S in combination with selected N sources on mean lint yields.

N Source	Sulfur	Lint Yields 1995	1996	1997
		--------- lbs/acre --------		
Ammonium Nitrate	Yes	1000	1099	1520
Ammonium Nitrate	No	1024	1040	1382
Urea	Yes	822	1317	1361
Urea	No	891	1197	1241
UAN	Yes	807	1169	1618
UAN	No	913	1274	1324
Probability		0.10	NS	0.10

Probability: probability that sulfur application affected lint yields.

Table 4. Mean lint yields as affected by the time of ammonium nitrate application. Probability refers to comparison of preplant application with other times of application.

Time of Ammonium Nitrate Application	Lint Yields 1995	1996	1997
	------------ lbs/acre ------------		
Preplant	1000	1099	1520
First True Leaf	957	1205	1503
First Square	1035	1269	1455
First Bloom	1058	1222	1420
Probability	NS	0.10	NS

Table 5. Effect of preplant and split (preplant/first square) applications of N on lint yields.

N Source	Timing	Lint Yields 1995	1996	1997
		-------- lbs/acre -------		
Ammonium Nitrate	Preplant	1000	1099	1520
Ammonium Nitrate	Preplant/First Square	881	1113	1356
Probability		NS	NS	NS
Ammonium Sulfate	Preplant	819	1389	1426
Ammonium Sulfate	Preplant/First Square	1066	1123	1431
Probability		0.10	0.10	NS

Table 6. Effect of split application of ammonium sulfate alone and when applied as a 50:50 mixture with urea or ammonium nitrate.

N Source	Timing	Lint Yields 1995	1996	1997
		--------- lbs/acre --------		
Ammonium Sulfate	Preplant/First Square	1066	1123	1431
Ammonium Sulfate/ Urea (50:50 mix)	Preplant/First Square	1072	1219	1464
Ammonium Sulfate/ Ammonium Nitrate (50:50 mix)	Preplant/First Square	985	1224	1455
Probability		NS	NS	NS

Table 7. Effect of applying supplemental K with ammonium sulfate on lint yields.

N Source	Timing	Lint Yields 1995	1996	1997
		--------- lbs/acre --------		
Ammonium Sulfate	Preplant/First Square	1066	1123	1431
Ammonium Sulfate + 60 lb K_2O /acre	Preplant/First Square	1095	1150	1498
Ammonium Sulfate + 60 lb K_2O /acre	Preplant/First Square/First Bloom	1016	1153	1530
Probability		NS	NS	NS