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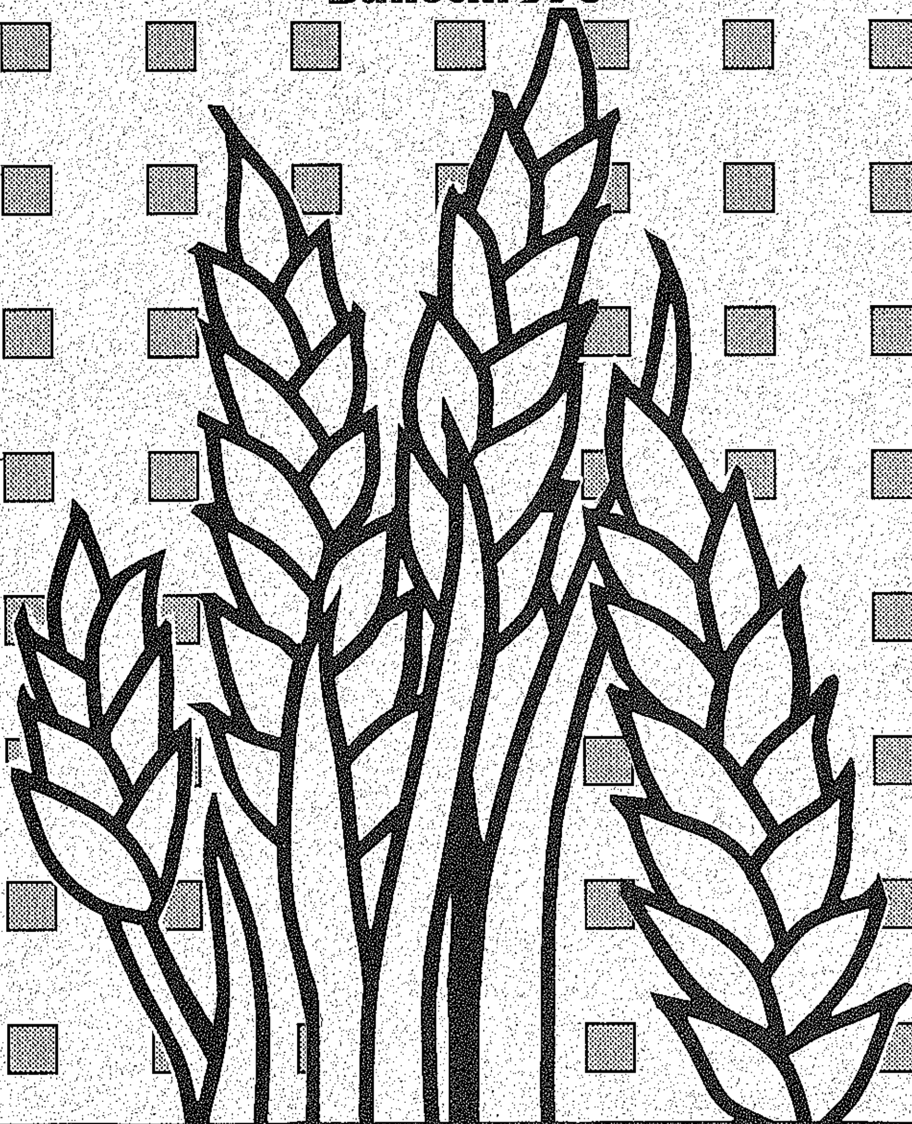

Nitrogen Requirements for Wheat in a Doublecropping System

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Abstract

Increasing costs associated with crop production require development and evaluation of more economical cropping systems. One factor to consider is more judicious use of nitrogen (N) fertilizer. This study was undertaken to determine the N requirements for wheat (*Triticum aestivum* L.) when grown following soybeans [*Glycine max* (L.) Merr.] in a doublecropping system. Experiments were conducted on sandy loam, silt loam, clay, and silty clay soils at seven Mississippi locations from 1985 to 1988. Nitrogen as ammonium nitrate or urea was applied to selected plots in the fall at planting with additional N applied in incremental rates in February or March. Optimum yields were obtained when N was applied to sandy loam and silt loam soils at rates from 40 to 120 lb/a, with most locations responding to 60 to 80 lb N/a. Optimum yields on clay and silty clay soils were obtained at N rates from 100 to 140 lb/a. There was no advantage to splitting applications of N between fall and spring as compared to applying all the N in mid-February to March 1. Nitrogen applied after March 1 usually reduced yields. Harvest index was not appreciably affected by rate or time of N application. Nitrogen use efficiency decreased with increasing rate of application. Efficiency of N use appeared to be influenced more by environmental conditions and degree of N response than rate or time of N application or soil texture. Nitrogen concentrations in grain and straw increased with rate of application. There were no differences, in any factor measured, due to source of N.

Introduction

Increasing costs associated with crop production are forcing both farmers and researchers to develop and evaluate more economical cropping systems. Sanford and Hairston (1984) reported that as much as 60 percent of wheat in the South is grown following soybeans. Touchton and Hargrove (1983) indicated that most of the wheat is doublecropped with soybeans in the Southeast, but considerable acreage is also doublecropped with nonleguminous crops such as grain sorghum, cotton, or corn. Lewis and Phillips (1976) concluded that doublecropping soybeans after wheat or barley was the most successful system in the southeastern United States.

Touchton and Hargrove (1983) reported that only 40 to 60 percent of the applied N may be recovered by many nonleguminous crops, including wheat. Crabtree and Rupp (1980) indicated that lower wheat yields were obtained following soybeans than when wheat was grown as a monocrop, although total grain yield was higher from the doublecrop. This suggests that the residual N from the soybean crop may not be immediately available for utilization by wheat. Hargrove et al. (1983) indicated that maximum yield of wheat following soybeans could be obtained from 75 lb N/a, whereas 94 lb N/a was needed for wheat following sorghum. Sanford et al. (1973) reported that higher wheat yields were obtained when wheat followed soybeans than when it followed sorghum. The lower yield following sorghum could have resulted from a net microbial immobilization of mineral N due to the wide C:N ratio of sorghum residue under decomposition (Hargrove et al., 1983).

Time of application can affect fertilizer N use efficiency. Olson (1987) reported that plant uptake and N content of grain were greater when fertilizer N was applied in the spring rather than in the fall. Touchton and Hargrove (1983) reported that optimum wheat yields could be obtained with optimum N applied in late winter or early spring with no N in the fall at planting. Sanford and Hairston (1984) observed the lack of response to fall-applied N when wheat followed soybeans. Boswell et al. (1976) indicated that splitting the N, 25 lb/a in the fall and 50 lb/a topdressed in the spring, was superior to applying all the N in the fall.

Frequent rains, continuously wet soils, and warm weather common during the winter months in the

Southeast can create conditions favorable for N losses by denitrification or leaching. Sanford and Hairston (1984) reported that wheat responded to higher rates of N applied to clay soils than applied to light-textured soils. Since yields for clay soils were frequently lower, a lower N use efficiency was indicated. Much of the wheat in the Southeast is grown following soybeans on heavy-textured soils where losses from denitrification can be significant.

Although there is an abundance of data comparing yields of wheat and soybeans in monocrop and doublecropping systems, much of the research has been directed toward wheat straw management and stand establishment in soybeans. Little attention has been given to fertility requirements of wheat following soybeans and even less to fall N requirements. The extent of availability of soybean residue N will determine the amount of additional N and the time of application required to maximize wheat yields in a doublecropping sequence. The objectives of this study were to determine (1) the optimum time and rate of N application to maximize grain yields of wheat following soybeans; (2) the effect of N application and soil texture on N use efficiency and harvest index; and (3) to further refine N recommendations for wheat grown following soybeans in a doublecropping sequence.

Materials and Methods

Field studies were conducted from 1985 to 1988 at seven locations in Mississippi. Locations and respective soil types were: North Mississippi Branch Station, Grenada silt loam (Glossic Fragiudalf, fine-silty, mixed, thermic); Northeast Mississippi Branch Station, Leeper silty clay loam (Vertic Haplaquept, fine, montmorillonitic, nonacid, thermic); Blackbelt Branch Station, Brooksville silty clay (Aquic Chromudert, fine, montmorillonitic, thermic); Coastal Plain Branch Station, Prentiss very fine sandy loam (Glossic Fragiudult, coarse-loamy, siliceous, thermic); South Mississippi Branch Station, Ruston fine sandy loam (Typic Paleudult, fine-loamy, siliceous, thermic); Brown Loam Branch Station, Loring silt loam (Typic Fragiudalf, fine-silty, mixed, thermic); and Delta Branch Station, Dubbs silt loam (Typic Hapludalf, fine-silty, mixed, thermic) and Tunica clay (Vertic Haplaquept, clayey over loamy, montmorillonitic, nonacid, thermic).

After soybean harvest, the test areas received a broadcast application of 60 lb/a P_2O_5 and 60 lb/a K_2O. The test areas were disked and the "best" adapted wheat cultivar for each location was planted with 7-inch drills. Wheat at the North Mississippi and Black Belt Branch Stations was planted no-till. Nitrogen as ammonium nitrate was applied surface broadcast March 1 to give 0, 20, 40, 60, 80, 120, or 160 lb/a. At locations where wheat was grown on clay soils, the 20 lb/a rate applied March 1 was omitted and the highest rate of N extended to 180 lb/a. Jones and Lancaster (1967) and Stevens et al. (1988) have shown urea and ammonium nitrate to be equally effective as sources of N for small grain. Studies at the Delta Branch Station used urea, applied at slightly different rates, as the source of N. Twenty pounds of N per acre were applied to selected plots in the fall after wheat emergence, usually in November or early December, with an additional 40 lb/a applied March 1. Selected plots received 60 lb N/a either February 15 or March 15. All other N was applied March 1.

In an attempt to determine the influence of soil texture on N use efficiency, an all-ammonium source (ammonium sulfate), an all-nitrate source (nitrate of soda), and ammomium nitrate were applied to selected plots at 40 lb N/a on March 1. To neutralize the effect of S in ammonium sulfate, sufficient S as calcium sulfate was applied to equal the S in ammonium sulfate. Although not an objective of this study, ammonium nitrate without S was included to measure any response to S that might occur. The experimental design was a randomized complete block with four replicates. Plot size was 10 by 40 feet with 10 feet between replicates.

Yields were determined by harvesting a 6-foot swath through the length of the plot. Grain samples were cleaned and yields were adjusted to 13 percent moisture. Whole plant samples were collected from each plot at harvest, dried at 75° C for 24 hours, and separated into grain and stover to determine harvest indices and N concentration.

Results and Discussion

Response of wheat to rates of N applied to light-textured soils is shown in Table 1. Yield increases were obtained from N rates varying from 40 lb/a to 120 lb/a, depending on location. These yields and N responses are typical of those obtained in previous years when wheat was grown as a monocrop. This would suggest that soybeans contributed very little available N for the succeeding wheat.

Wheat yields grown on heavy-textured soils are shown in Table 2. Yield increases were obtained from 100 to 140 lb N/a. These yields are slightly higher than those obtained on light-textured soils. This has not been the usual pattern. Traditionally, these soils have produced yields lower than those obtained on lighter-textured soils and required higher rates of N. During the winter and early spring, clay soils are usually very wet which results in poor wheat growth and consequently lower yields. Environmental conditions for 1986 through 1988 were ideal (low rainfall

Table 1. The influence of rate and time of N application on yield of wheat grown on sandy loam and silt loam soils at four locations for 3 to 4 years.

Rate of N	North Miss. (4 yr)	South Miss. (4 yr)	Coastal Plain (4 yr)	Brown Loam (3 yr)	Average (15 loc x yr)
lb/a			bu/a		
0	20	19	10	21	17
20	29	25	19	30	25
40	34	27	24	37	30
60	36	29	29	43	34
80	37	30	32	44	35
120	38	30	33	50	37
160	37	29	32	48	36
20F+40S[1]	36	32	27	37	33
Feb 15[2]	36	29	30	42	34
Mar 15[2]	36	26	27	42	32
C.V. (%)	20.5	11.6	19.1	11.9	16.2
LSD (0.05)	5	2	4	4	2

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 2. The influence of rate and time of N application on yield of wheat grown on clay loam and silty clay soils at two locations for 3 years.

Rate Of N	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (6 loc x yr)
lbs/a		bu/a	
0	40	25	32
40	63	43	53
60	68	50	59
80	74	52	63
100	77	57	67
140	79	47	63
180	77	48	62
20F+40S[1]	64	50	57
Feb 15[2]	62	55	58
Mar 15[2]	60	42	51
C.V. (%)	9.0	10.9	9.8
LSD (0.05)	5	4	3

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

and cooler than normal air temperature in April and May) for wheat grown on clay soils. These weather conditions are likely to produce a moisture stress on light-textured soils.

Traditionally, in a monocrop system, a small amount of N has been applied at planting to help establish an adequate root system to reduce winter kill. Yield data in Tables 1 and 2 suggest that a fall application of N is not needed when wheat follows soybeans. This agrees with results obtained by Touchton and Hargrove (1983) and Sanford and Hairston (1984). At two of four locations where wheat was grown on sandy or silt loam soils, there was a reduction in yield from splitting the N between fall and spring when compared to applying all the N in mid-February or March 1. The South Mississippi location was the only place where splitting the N between fall and spring was superior to applying all the N in the spring. Delaying N application until March 15 usually reduced yields when compared to applying N in mid-February to March 1. This same trend in response to time of N application was evident for wheat grown on clay and clay loam soils.

Harvest indices (percent of above-ground portion that is grain) for all locations and years are reported in Tables 3 and 4. The relationship between rate of N application and harvest index was inconsistent. Applying N to light-textured soils decreased the harvest index at two locations and increased it at two locations, Table 3. When N was applied to heavy-textured soils, harvest index was increased at one location and unaffected at the other location, Table 4. Harvest index tended to be lower with the higher rates of N, however, all of these changes were small. Harvest index was generally unaffected by time of N application regardless of soil texture. This suggests, and visual observations confirm, that most of the yield increases from applied N were a result of increased tillering.

To get a better indication of efficiency of N use as affected by rate of application and soil texture, the pounds of N required to produce a bushel of wheat were averaged across years and locations and are reported in Table 5. Nitrogen use efficiency decreased with rate of application. Nitrogen was used more ef-

Table 3. The influence of rate and time of N application on harvest index of wheat grown on sandy loam and silt loam soils at four locations for 3 to four years.

Rate of N	North Miss. (4 yr)	South Miss. (4 yr)	Coastal Plain (4 yr)	Brown Loam (3 yr)	Average (15 loc x yr)
lb/a			harvest index		
0	43	40	35	39	39
20	44	40	36	39	40
40	45	40	39	39	41
60	43	39	37	38	39
80	44	38	39	38	40
120	40	37	36	37	38
160	41	36	35	36	37
20F+40S[1]	43	40	38	38	40
Feb 15[2]	42	38	37	38	39
Mar 15[2]	46	39	38	38	40
C.V. (%)	5.0	7.2	8.7	5.0	6.6
LSD (0.05)	2	2	2	2	1

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

ficiently on heavy-textured soils than on light-textured soils. This has not been the usual pattern. The higher than normal yields on the heavy- textured soils account for more efficient use of applied fertilizer N. Nitrogen use efficiency for individual years (data not shown) was quite variable. This variability appeared to be influenced more by weather conditions and degree of response to applied N than by soil texture. When weather conditions were such that higher than normal yields were obtained, N use efficiency was high. Consequently, when weather conditions were such that lower than normal yields were obtained, N use efficiency was low.

Grain quality and size are often affected by fertilization and environmental conditions. Bushel test weight (BTW) was determined and the results are reported in Tables 6 and 7. There were few differences in BTW among locations, rates of N application, or due to soil texture. In individual years (data not shown), BTW was influenced by environmental conditions. When

Table 4. The influence of rate and time of N application on harvest index of wheat grown on clay loam and silty clay soils at two locations for 3 years.

Rate Of N	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (6 loc x yr)
lb/a		harvest index	
0	43	39	41
40	44	42	43
60	44	42	43
80	43	40	42
100	44	36	40
140	43	37	40
180	44	37	40
20F+40S[1]	43	42	42
Feb 15[2]	43	43	43
Mar 15[2]	44	41	42
C.V. (%)	5.4	8.5	6.9
LSD (0.05)	ns	3	ns

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 5. The influence of rate of N application and soil texture on pounds of N required per bushel of wheat. Four locations for 3 to 4 years on sandy loam and silt loam soils. Two locations for 3 years on clay loam and silty clay soils.

Rate of N	Sandy loam and silt loam soils	Clay loam and silty clay soils
lb/a	lb N/bu	
20	2.5	–
40	3.1	1.9
60	3.5	2.2
80	4.4	2.6
100	–	2.9
120	6.0	–
140	–	4.5
160	8.4	–
180	–	6.0

Nitrogen applied March 1.

Table 6. The influence of rate and time of N application on bushel test weight (BTW) of wheat grown on sandy loam and silt loam soils at four locations for 3 to 4 years.

Rate of N	North Miss. (4 yr)	South Miss. (4 yr)	Coastal Plain (4 yr)	Brown Loam (3 yr)	Average (15 loc x yr)
lb/a			BTW		
0	55	55	55	58	56
20	56	54	55	58	56
40	55	55	55	58	56
60	55	54	55	58	55
80	55	54	54	58	55
120	53	52	53	57	54
160	53	53	52	57	54
20F+40S[1]	55	54	56	58	56
Feb 15[2]	56	54	55	58	56
Mar 15[2]	55	54	54	58	55
C.V. (%)	1.9	2.4	3.5	1.2	2.6
LSD (0.05)	1	1	1	ns	ns

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 7. The influence of rate and time of N application on bushel test weight (BTW) of wheat grown on clay loam and silty clay soils at two locations for 3 years.

Rate Of N	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (6 loc x yr)
lbs/a		BTW	
0	56	57	56
40	56	58	57
60	56	58	57
80	56	57	56
100	56	57	56
140	55	57	56
180	55	56	56
20F+40S[1]	56	57	56
Feb 15[2]	56	57	56
Mar 15[2]	56	58	57
C.V. (%)	1.1	1.0	1.0
LSD (0.05)	ns	ns	ns

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

conditions were such that optimum grain yields were obtained, BTW's were higher than when low grain yields were obtained.

Nitrogen concentrations of grain and straw were determined for each treatment. These data for light- and heavy-textured soils are reported in Tables 8 through 11. Nitrogen concentrations of grain and straw generally increased with rate of application. The influence of time of N application on grain concentration was inconsistent. When N applications to sandy loam and silt loam soils were split between fall and spring, grain N concentrations were slightly lower than when applied March 1 at three locations and higher at one location, Table 8. Few differences were seen in grain N concentrations on the clay loam and silty clay loam soils due to splitting N applications, Table 9. Straw N concentrations at the South Mississippi and Brown Loam Stations were noticeably lower when N application was split between fall and spring as compared to applying all the N on March 1, Table 10.

There was little difference in straw N concentration

Table 8. The influence of rate and time of N application on percent N in wheat grain grown on sandy loam and silt loam soils at four locations for 3 to 4 years.

Rate of N	North Miss. (4 yr)	South Miss. (4 yr)	Coastal Plain (4 yr)	Brown Loam (3 yr)	Average (15 loc x yr)
lb/a			% N		
0	1.7	1.9	1.9	1.8	1.8
20	1.8	2.0	1.8	1.7	1.8
40	1.9	2.1	1.8	1.6	1.9
60	2.0	2.3	2.0	1.8	2.0
80	2.2	2.4	1.9	1.8	2.1
120	2.7	2.5	2.2	2.1	2.4
160	2.7	2.7	2.4	2.4	2.6
20F+40S[1]	2.1	2.0	1.9	1.6	1.4
Feb 15[2]	1.8	2.2	1.9	1.7	1.9
Mar 15[2]	2.0	2.4	2.2	1.9	2.1
C.V. (%)	9.0	9.0	11.6	7.7	9.4
LSD (0.05)	0.1	0.1	0.1	0.1	<0.1

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 9. The influence of rate and time of N application on percent N in wheat grain grown on clay loam and silty clay soils at two locations for 3 years.

Rate Of N	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (6 loc x yr)
lbs/a		% N	
0	1.5	1.7	1.6
40	1.6	1.6	1.6
60	1.6	1.7	1.6
80	1.7	1.8	1.8
100	1.9	2.0	2.0
140	2.0	2.3	2.2
180	2.0	2.4	2.2
20F+40S[1]	1.5	1.6	1.6
Feb 15[2]	1.5	1.6	1.6
Mar 15[2]	1.7	1.8	1.8
C.V. (%)	27.7	9.3	9.1
LSD (0.05)	0.1	0.1	0.1

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 10. The influence of rate and time of N application on percent N in wheat straw grown on sandy loam and silt loam soils at four locations for 3 to 4 years.

Rate of N	North Miss. (4 yr)	South Miss. (4 yr)	Coastal Plain (4 yr)	Brown Loam (3 yr)	Average (15 loc x yr)
lb/a			% N		
0	0.38	0.45	0.54	0.39	0.44
20	0.41	0.42	0.46	0.32	0.41
40	0.43	0.48	0.38	0.34	0.41
60	0.49	0.60	0.46	0.42	0.50
80	0.62	0.74	0.44	0.43	0.57
120	0.77	0.74	0.56	0.63	0.68
160	0.89	0.87	0.82	0.70	0.83
20F+40S[1]	0.48	0.46	0.49	0.33	0.45
Feb 15[2]	0.38	0.56	0.46	0.38	0.45
Mar 15[2]	0.50	0.66	0.67	0.47	0.58
C.V. (%)	23.2	18.7	23.6	21.4	24.0
LSD (0.05)	0.09	0.08	0.09	0.08	0.05

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N /a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 11. The influence of rate and time of N application on percent N in wheat straw grown on clay loam and silty clay soils at two locations for 3 years.

Rate Of N	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (6 loc x yr)
lbs/a		% N	
0	0.24	0.35	0.30
40	0.26	0.32	0.29
60	0.26	0.35	0.30
80	0.29	0.39	0.34
100	0.37	0.48	0.42
140	0.53	0.67	0.60
180	0.45	0.83	0.64
20F+40S[1]	0.25	0.30	0.28
Feb 15[2]	0.25	0.32	0.28
Mar 15[2]	0.32	0.37	0.34
C.V. (%)	8.7	20.5	23.3
LSD (0.05)	0.07	0.07	0.05

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 12. The influence of sulfur and source of N on yield of wheat at four locations for 3 to 4 years.

Source of N	Coastal Plain (4 yr)	Brown Loam (4 yr)	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (14 loc x yr)
	bu/a				
Am. Nit.	24	37	63	43	40
Am. Nit. + S[1]	25	35	62	46	40
Nit. Soda + S[1]	25	38	63	46	41
Am. Sul.	25	35	63	41	39
C.V. (%)	17.8	12.6	5.9	9.7	10.4
LSD (0.05)	ns	ns	ns	2	2

Nitrogen applied March 1 at 40 lb/a.
[1]Sufficient sulfur as calcium sulfate applied to equal sulfur in ammonium sulfate.

Table 13. The influence of sulfur and source of N on harvest index of wheat grown at four locations for 3 to 4 years.

Source of N	Coastal Plain (4 yr)	Brown Loam (4 yr)	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (14 loc x yr)
	harvest index				
Am. Nit.	39	39	44	42	41
Am. Nit. + S[1]	39	39	43	41	40
Nit. Soda + S[1]	38	38	44	42	40
Am. Sul.	38	38	44	43	40
C.V. (%)	6.1	5.1	4.1	4.3	4.9
LSD (0.05)	ns	ns	ns	2	ns

Nitrogen applied March 1 at 40 lb/a.
[1]Sufficient sulfur as calcium sulfate applied to equal sulfur in ammonium sulfate.

due to splitting N applications on the clay loam and silty clay loam soils, Table 11. Delaying N applications until March 15 increased concentrations in both grain and straw for all soils without increasing yields.

There were few differences in grain yield, harvest index, bushel test weight, grain N concentration, or straw N concentration at any location due to source of N, Tables 12 through 16. There was no response to S at any location.

Data from the Delta Branch Station are shown in Tables 17 and 18. Maximum grain yields on both clay and sandy loam soils were obtained with 150 lb N/a. Rate of N had no effect on harvest index or bushel test weight. Nitrogen concentration in grain and straw increased slightly with rate of application. Nitrogen use efficiency decreased as the rate of N increased. There was a considerable decrease in N use efficiency at rates of N above that required for maximum yields. There was no real advantage to applying part of the N in the fall at planting as opposed to applying all the N in late February to early March. Applying N about March 15 produced slightly lower yields on clay soils but not on the sandy loam soils.

Conclusions

Highest wheat grain yields were produced when N was applied from mid-February to March 1. There is no advantage to splitting N between fall and spring compared to applying all N in the spring when wheat follows soybeans in a doublecropping system. Generally, optimum grain yields were obtained on sandy and silt loam soils with 60 to 80 lb N/a and on clay and silty clay soils with 100 to 140 lb N/a. Nitrogen use efficiency varied within locations and years. Efficiency of N use decreased with rate of application and appeared to be influenced more by environmental conditions than by soil texture. Soil texture and N application had little effect on harvest index. There were no differences, in any factor measured, among sources of N.

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Table 14. The influence of sulfur and source of N on bushel test weight (BTW) of wheat grown at four locations for 3 to 4 years.

Source of N	Coastal Plain (4 yr)	Brown Loam (4 yr)	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (14 loc x yr)
	BTW				
Am. Nit.	55	58	56	58	57
Am. Nit. + S[1]	56	58	56	57	57
Nit. Soda + S[1]	55	58	56	58	56
Am. Sul.	56	58	56	57	57
C.V. (%)	2.6	0.7	0.7	0.9	1.5
LSD (0.05	ns	ns	ns	ns	ns

Nitrogen applied March 1 at 40 lb/a.
[1]Sufficient sulfur as calcium sulfate applied to equal sulfur in ammonium sulfate.

Table 15. The influence of sulfur and source of N on percent N in wheat grain at four locations for 3 to 4 years.

Source of N	Coastal Plain (4 yr)	Brown Loam (4 yr)	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (14 loc x yr)
	% N				
Am. Nit.	1.8	1.6	1.6	1.6	1.7
Am. Nit. + S[1]	1.8	1.6	1.6	1.7	1.7
Nit. Soda + S[1]	1.8	1.6	1.5	1.6	1.6
Am. Sul.	1.8	1.6	1.5	1.6	1.6
C.V. (%)	5.8	5.8	6.5	8.2	6.6
LSD (0.05)	ns	ns	ns	ns	ns

Nitrogen applied March 1 at 40 lb/a.
[1]Sufficient sulfur as calcium sulfate applied to equal sulfur in ammonium sulfate.

Table 16. The influence of sulfur and source of N on percent N in wheat straw at four locations for 3 to 4 years.

Source of N	Coastal Plain (4 yr)	Brown Loam (4 yr)	Northeast Miss. (3 yr)	Black Belt (3 yr)	Average (14 loc x yr)
	% N				
Am. Nit.	0.38	0.34	0.26	0.32	0.33
Am. Nit. + S[1]	0.42	0.35	0.26	0.32	0.34
Nit. Soda + S[1]	0.46	0.36	0.26	0.30	0.35
Am. Sul.	0.39	0.35	0.27	0.30	0.33
C.V. (%)	13.7	19.5	15.0	14.6	15.9
LSD (0.05)	0.04	ns	ns	ns	ns

Nitrogen applied March 1 at 40 lb/a.
[1]Sufficient sulfur as calcium sulfate applied to equal sulfur in ammonium sulfate.

Table 17. The influence of rate and time of N application on yield (bu/a), harvest index (HI), bushel test weight (BTW), N concentration in straw (% N-S), N concentration in grain (% N-G), and N use efficiency (lb N/bu) of wheat grown on a clay soil at the Delta Branch Station for 2 years.

lb N/a	bu/a	HI	BTW	%N-S	%N-G	lb N/bu
0	23	40	54	0.35	1.8	–
30	38	40	56	0.35	1.7	2.0
60	43	40	56	0.34	1.8	3.0
90	48	39	54	0.42	1.9	3.6
120	50	40	54	0.42	2.0	4.4
150	54	42	56	0.44	2.1	4.8
180	54	40	55	0.60	2.3	5.8
20F + 40S[1]	46	38	56	0.44	2.6	2.6
Feb 15[2]	48	38	55	0.36	1.7	2.4
Mar 15[2]	44	41	56	0.43	1.9	2.9
C.V. (%)	12.3	9.6	2.2	33.8	9.7	–
LSD (0.05)	6	ns	1	0.14	0.2	–

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

Table 18. The influence of rate and time of N application on yield (bu/a), harvest index (HI), bushel test weight (BTW), N concentration in straw (% N-S), N concentration in grain (% N-G), and N use efficiency (lb N/bu) of wheat grown on a sandy loam soil at the Delta Branch Station for 2 years.

lb N/a	bu/a	HI	BTW	%N-S	%N-G	lb N/bu
0	39	40	57	0.22	1.5	–
30	52	40	57	0.26	1.6	2.5
60	61	38	57	0.30	1.7	2.7
90	60	40	57	0.29	1.8	4.3
120	61	38	58	0.36	2.0	5.5
150	66	38	57	0.44	2.2	5.6
180	63	38	57	0.47	2.3	7.5
20F + 40S[1]	56	38	57	0.24	1.6	3.5
Feb 15[2]	58	38	57	0.26	1.7	3.2
Mar 15[2]	57	40	58	0.28	1.7	3.3
C.V. (%)	9.8	6.6	1.3	19.5	8.5	–
LSD (0.05)	6	ns	ns	0.06	0.2	–

Nitrogen applied March 1 except as noted.
[1]20 lb N/a in fall at planting, 40 lb N/a March 1.
[2]Nitrogen applied at 60 lb/a.

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