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Limestone and Nitrogen Application Influence on Cotton Yields and Soil Tests

in a
Tiptonville Silt Loam Soil
in Southeast Missouri

JAMES A. ROTH AND THOMAS E. FISHER

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SUMMARY

Seed cotton yields were not influenced significantly by the application of limestone on the Tiptonville silt loam soil (pHs 5.3) except with the application of four tons of fine lime, which significantly reduced the total yield over the seven-year period.

The application of limestone, as measured by the soil test, reduced exchangeable potassium, compared to the check plot which received the same potash application. More potassium was available at the termination of the experiment on the fine lime plots than on the agricultural limestone plots. Limestone did not apparently affect phosphate, magnesium, or the cation exchange capacity. Limestone did increase the calcium content and pHs but reduced neutralizable acidity as determined by the soil tests.

The 63-pound rate of N application increased yields of seed cotton significantly higher than the 38-pound application. The high rate (113 pounds) significantly reduced first picking and gave only a 19-pound increase in yield, which was not significantly different.

ACKNOWLEDGEMENT

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Cotton requirements for calcium and nitrogen have been of major concern to farmers of southeast Missouri. With the application of each pound of nitrogen as ammonium nitrate, 1.8 (2)[1] to 3.57 (4) pounds of calcium carbonate are required to neutralize the acid produced by the chemical reaction in the soil. A question arises as to the cotton plant's requirement for calcium or for the control of soil acidity in order to create a more optimum environment for the availability of nutrients.

Acording to Neal and Lovett, as reported in "Hunger Signs in Crops" (5), a low pH causes "crinkle leaf" (manganese toxicity) which results in an excess of water soluble manganese in the soil solution. Increasing the pH by the addition of limestone eliminates the cause of "crinkle leaf" in cotton. The objectives of this study were to determine the optimum range of soil pH as well as to determine the effect of agricultural limestone as compared to fine limestone of less than 100 mesh. Also included in the objectives was to determine optimum rate of nitrogen and what effect if any that nitrogen had on the soil pH over a period of years. This study provided an opportunity to observe other changes in soil test values over a period of years.

EXPERIMENTAL PROCEDURE

A field experiment was initiated on a Tiptonville silt loam soil, sandy loam overwash located seven miles southeast of Portageville. The Tiptonville series consists of deep friable, acid, dark-colored, level to very gently sloping well-drained soils on the high rim of the old natural levees (1). Tiptonville silt loam is fertile, easy to till and suitable to all row crops, small grains, grasses, and legumes. The subsoil is moderately permeable and has a high available moisture capacity.

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[1]Numbers in parentheses are keyed to References at the end of the bulletin.

A split plot design was used with the main blocks receiving four rates of calcium carbonate as agricultural limestone[2] from Jonesboro, Ill., and four rates of fine lime[3] from Ste. Genevieve, Mo. Three replications of four-row plots 90 feet long were included in each sub-plot or treatment. All limestone treatments, except the annual treatment, were applied broadcast and plowed down after disking into the soil thoroughly. No additional limestone was applied throughout the duration of the experiment except on the plot which received 500 pounds of fine lime banded by the row annually, after the cotton had emerged.

A recommended variety of cotton was planted in 38 inch rows as near to the first of May as soil conditions permitted. Cotton was grown continuously on the same plots throughout the experiment. Annually, 13 pounds of nitrogen, 50 pounds of phosphate, and 50 pounds of potash were applied to all plots at time of planting. The additional nitrogen was sidedressed just prior to blooming. This included three treatments of 38, 63, and 113 pounds of total nitrogen.

All cotton plots were irrigated by the row method as needed, ranging from one to three applications, depending on the season. Herbicides were used to control weeds and cultivation was minimal. Insects were controlled when necessary by chemical sprays.

The mechanical spindle picker was used to harvest the center two rows of each of the four-row plots for yield determinations. Samples of seed cotton were obtained to determine lint percentage, staple, and number of bolls per pound. Quality of lint data were not included in this publication as differences between treatments were not statistically significant.

Initial soil samples were obtained from each plot previous to any soil treatments and following the annual harvest. Soil samples were analyzed according to methods used in the soil testing laboratories of Missouri (3) and are reported in Tables 1 through 8. Duration of the experiment included seven years with final soil samples obtained after completion of the seventh harvest of seed cotton (Table 8).

The data were evaluated by Duncan's New Multiple Range Test (5% level of significance) as a split block design.

RESULTS AND DISCUSSION

Limestone applications on a Tiptonville silt loam soil (initial pHs[4] of 5.3) resulted in a non-significant effect on seed cotton yields over a seven-year period, 1962-69. This indicates that a pHs range of from 5.3 to 6.8 was satisfactory for optimum cotton production on this soil type (Table 9).

[2]Agricultural grade limestone—98.2% calcium carbonate with 56.5% passing through a 40 mesh sieve.

[3]Fine lime—98.5% calcium carbonate with 100% passing through a 100 mesh sieve and 80% through a 200 mesh sieve.

[4]Refers to salt pH (pHs) as measured in 1:1 soil: 0.01M $CaCl_2$ suspension.

The fine lime increased the pHs to a higher level, compared to a similar amount applied of agricultural limestone but resulted in a more rapid rate of decline following the peak one year after application (Figure 1). The four-ton application of agricultural limestone reached as high a pH as the same rate of fine lime and maintained the same pHs (6.0 to 6.1) throughout the experiment. Plots receiving all rates of limestone completed the experiment at a higher pHs level than the check treatment. This would indicate the initial limestone treatments were effective longer than the eight-year duration of the experiment.

The optimum rate of nitrogen on this soil appeared to be 63 pounds per acre. The higher rate of 113 pounds was not significantly different from the 63-pound rate. The high (113 pound) rate of nitrogen significantly reduced the pHs, compared to the 63 pound rate, on the Tiptonville silt loam soil but the reduction was only 0.1 pHs. For the reduction in pHs to be of any concern, rates of nitrogen would probably have to be considerably higher than optimum cotton production would tolerate.

Soil Test Results

Organic Matter: Over the period of eight years the percentage of organic matter in the soil was reduced an average of 0.16 (Table 10). There appeared to be no relationship between the soil treatments and organic matter content; the reduction was probably due to depletion under a continuous row cropping of cotton with an insufficient amount of organic matter returned to the soil to maintain the original content.

Phosphate: With the application of a total of 350 pounds of phosphate there was an average increase of 38 pounds as determined by soil test over the eight years. The soil treatments, limestone or nitrogen, did not appear to influence the phosphate content of the soil (Table 10).

Potassium: During the seven years, 291 pounds of potassium were applied to all plots. The no-limestone showed an increase of 109 pounds (Table 10) of potassium whereas the plots on which limestone was applied experienced a range of reaction from an increase of 98 pounds (1 ton fine limestone) to a decrease of 27 pounds (4 tons fine limestone). There appears to be an indirect relationship between potassium content of the soil and rate of limestone application.

Magnesium: Magnesium was not applied to the plots during the experiment but soil tests indicate an average increase of 50 pounds of exchangeable magnesium over the eight years on all treatments. Neither limestone nor nitrogen treatments could explain the change in magnesium content of the soil (Table 10).

Calcium: The exchangeable calcium (Table 10) increased with the addition of limestone on most treatments. For some unknown reason the four-ton application of fine lime decreased 133 pounds, which was a decrease of 10 pounds

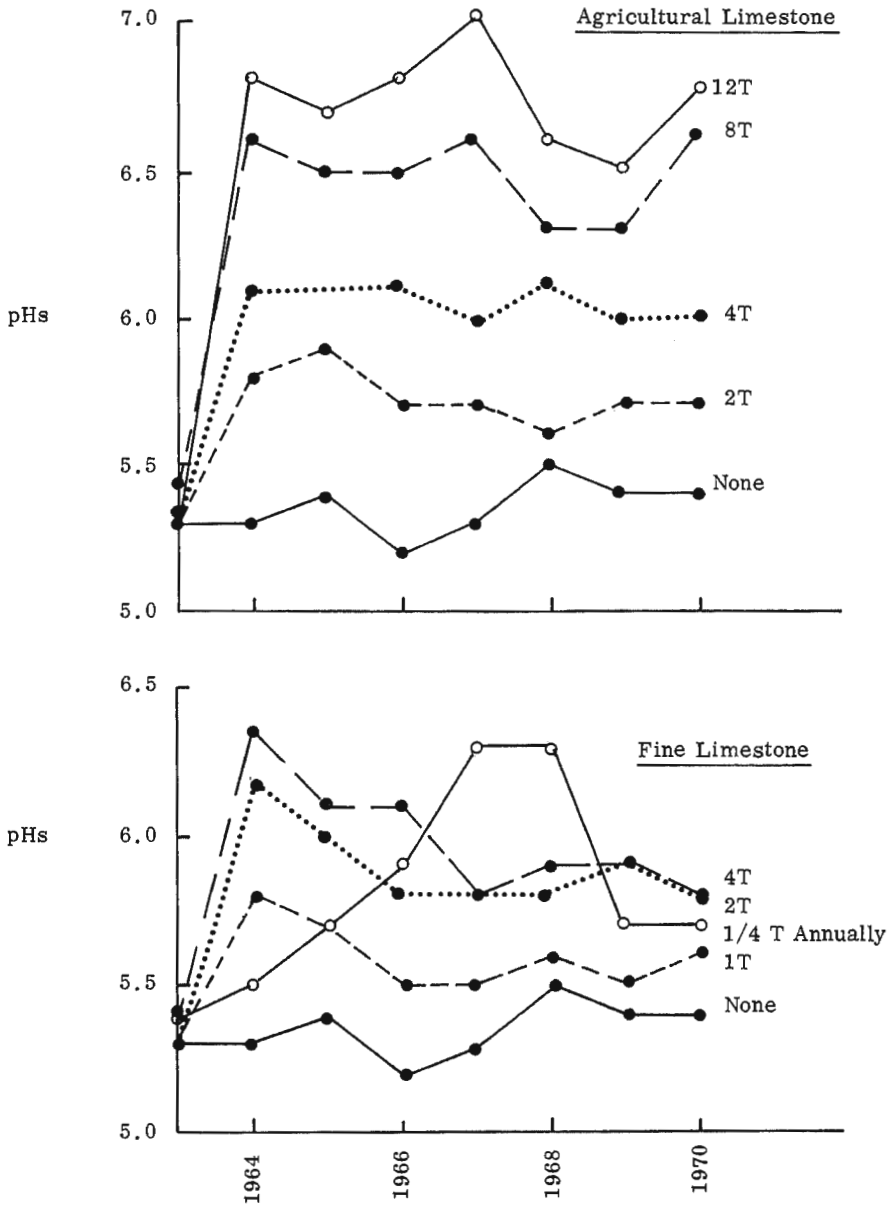

Figure 1: Influence of agricultural and fine limestone on pHs over eight year period 1963-70.

more than the no-treatment plot. In viewing the data (Tables 1 through 8) the soil test for exchangeable calcium appeared to be irratic and no explanation for the results obtained. There was an increase of calcium content of the soil on seven of the limestone treatments and a decrease on two of the limestone treatments. The two ton rate of limestone application increased the content 444 pounds of calcium whereas the four ton rate resulted in a decrease of 133 pounds. Five hundred pounds of fine lime applied annually (total of 3,500 pouds) seemed to be as effective as any of the treatments applied.

N.A.: Neutralizable acidity increased on the no treatment plots and on the plots on which low rates of limestone were applied. On the plot with four tons of fine limestone there was also a decline of 0.6. The agricultural limestone was more effective in decreasing the neutralizable acidity, compared to fine lime, over the eight-year duration of the experiment.

pHs: The salt pH (pHs) increased with the application of limestone and at the conclusion of the experiment the pHs of all treatments were above the initial pHs. The fine lime reached a higher pHs level than the agricultural limestone of same rate of application but the latter maintained a higher pHs throughout the duration of the experiment (Figure 1).

C.E.C.: The cation exchange capacity increased over the eight-year period but neither limestone nor nitrogen appeared to influence the soil test results (Table 10).

Seed Cotton Yields: Limestone did not significantly increase yields of seed cotton on the Tiptonville silt loam soil over the seven-year duration of the experiment, 1963 through 1969. On one treatment (four tons of fine lime), the average yield was significantly reduced. The data (Table 9) indicate that a pHs of 5.3 was sufficient and increasing the pHs to 6.7 was not justified on this soil during the years the experiment was conducted. Nitrogen increased total yields of seed cotton up to 113 pounds total nitrogen per acre (Table 9) but results with the 113 pounds were not different from those with 63 pounds. The high rate of nitrogen depressed yields of seed cotton at the first picking. The high rate of nitrogen (113 pounds) resulted in excessive vegetative growth which tended to reduce yields in 1964 (Table 2).

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APPENDIX

Table 1: Soil Test Results[5] and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1963

Soil Treatment	%	Lb/A	Exchangeable Lbs/A						Seed Cotton Yield-Lb/A[6]	
Limestone	O.M.	P_2O_5	K	Mg.	Ca	N.A.	pHs	C.E.C.	1st Pick	Total
None (1)	2.23a-f	226b-g	320b-e	213c-g	3367b-g	2.50ab	5.23b	12.00b-f	2186a-d	2821ghi
None (2)	2.17c-g	232a-g	337a-e	207c-g	3433b-g	2.33abc	5.27b	12.00b-f	1919fgh	2752hi
None (3)	2.27a-e	250a-d	300cde	187d-g	3567b-g	2.50ab	5.30ab	12.50a-f	2026def	2841ghi
1/ 2 Tons (1)	2.40a-d	243a-e	363a-e	253b-f	3967ab	2.17abc	5.27b	13.50a-d	2255ab	2930e-h
2 Tons (2)	2.50ab	233a-f	363a-e	273a-e	3833a-d	2.17abc	5.27b	13.17a-d	2306a	3106b-e
2 Tons (3)	2.43abc	233a-f	330a-e	293abc	4000ab	2.33abc	5.23b	13.83abc	2303a	3193ab
4 Tons (1)	2.57a	271ab	333a-e	200c-g	3867abc	2.67a	5.23b	13.50a-d	2212abc	2968c-g
4 Tons (2)	2.50ab	279a	377abc	240b-f	3833a-d	2.30abc	5.33ab	13.33a-d	2026def	2900fgh
4 Tons (3)	2.50ab	262abc	327a-e	293abc	3933ab	2.50ab	5.33ab	13.83abc	2100b-f	3142abc
8 Tons (1)	2.20b-g	245a-e	347a-e	240b-f	3733a-e	2.00bc	5.37ab	12.83a-f	2102b-e	2968c-g
8 Tons (2)	2.20b-g	239a-e	353a-e	240b-f	4633a	2.00bc	5.30ab	15.00a	2201a-d	3149abc
8 Tons (3)	2.13c-h	241a-e	353a-e	280a-d	4100ab	2.33abc	5.40ab	14.17ab	2064c-f	3101b-e
12 Tons (1)	2.00e-h	177hi	343a-e	253b-f	3600b-g	2.17abc	5.30ab	12.50a-f	2224abc	2968c-g
12 Tons (2)	2.13c-h	186f-i	333a-e	200c-g	3633b-g	2.50ab	5.33ab	12.67a-f	2260ab	3198ab
12 Tons (3)	1.87gh	185f-i	357a-e	273a-e	3667b-f	2.33abc	5.23b	13.00a-e	2222abc	3198ab
2/ 1 Ton (1)	1.93e-h	205d-i	297de	307ab	2967c-g	2.17abc	5.27b	11.17d-f	2189a-d	2917e-h
1 Ton (2)	2.07d-h	216c-i	327a-e	253b-f	2800efg	2.00bc	5.50a	10.33f	2049c-f	3058b-f
1 Ton (3)	1.93e-h	219c-i	340a-e	213c-g	2867efg	2.00bc	5.23b	10.50ef	1990efg	3124a-d
2 Tons (1)	1.83h	174i	330a-e	293abc	2700g	1.83c	5.33ab	10.33f	2219abc	2948d-g
2 Tons (2)	1.80h	175hi	353a-e	207c-g	2900d-g	2.00bc	5.30ab	10.50ef	1962e-h	2986c-g
2 Tons (3)	1.90fgh	184ghi	350a-e	220b-g	2767fg	2.00bc	5.33ab	10.33f	2094b-f	3126a-d
4 Tons (1)	2.37a-d	244a-e	403a	173fg	3367b-g	2.17abc	5.30ab	11.83b-f	1827gh	2573i
4 Tons (2)	2.27a-e	247a-e	380ab	180efg	3333b-g	2.00bc	5.33ab	11.67b-f	1980efg	2752hi
4 Tons (3)	2.07d-h	200e-i	370a-d	140g	3333b-g	2.33abc	5.30ab	11.50c-f	1796h	2688ij
3/ 500 Lbs. (1)	1.93e-h	223b-h	290e	353a	2767fg	2.17abc	5.30ab	11.00d-f	2184ad	2846ghi
500 Lbs. (2)	1.93e-h	219c-i	303b-e	260a-f	2767fg	2.00bc	5.37ab	10.33f	2339a	3083b-f
500 Lbs. (3)	1.87gh	210d-i	293de	287abc	2833efg	1.83c	5.43ab	10.33f	2349a	3305a
Min. LSR,LSD	0.31	41.5	64.8	83.8	808.3	0.50	0.17	2.18	155.6	164.3
Max. LSR	0.37	49.5	77.4	100.0	964.5	0.59	0.21	2.60	185.7	196.0
C.V. %	8.5	11.1	11.4	20.6	14.0	13.5	2.0	10.7	4.4	3.3
					LIMESTONE MEANS					
None	2.22ab	236a	319ab	202ab	3456ab	2.44a	5.27a	12.17a	2043ab	2804a
2 Tons[1]	2.44ab	236a	352ab	273a	3933ab	2.22a	5.26a	13.50ab	2288a	3076a
4 Tons	2.52a	271a	346ab	244ab	3878ab	2.49a	5.30a	13.56ab	2112ab	3003a
8 Tons	2.18ab	242a	351ab	253ab	4156a	2.11a	5.36a	14.00a	2122ab	3073a
12 Tons	2.00ab	183a	344ab	242ab	3633ab	2.33a	5.29a	12.72ab	2235ab	3121a
1 Ton[2]	1.98ab	213a	321ab	258ab	2878b	2.06a	5.33a	10.67b	2076ab	3033a
2 Tons	1.84ab	178a	344ab	240ab	2789b	1.94a	5.32a	10.39b	2092ab	3020a
4 Tons	2.23ab	230a	384a	164b	3344ab	2.17a	5.31a	11.67ab	1868b	2671a
500 Lbs.[3]	1.91ab	217a	296b	300a	2789b	2.00a	5.37a	10.56b	2291a	3078a
Min. LSR,LSD	0.59	96.1	60.0	91.5	1081.0	0.48	0.13	2.94	355.1	470.2
Max. LSR	0.68	109.2	68.2	104.0	1229.0	0.54	0.15	3.34	403.6	534.4
C.V. %	27.7	43.1	17.7	37.8	31.5	21.8	2.5	24.2	16.7	15.7
					NITROGEN MEANS					
38+50+50[4]	2.16a	223a	336a	254a	3370a	2.20a	5.29a	12.07a	2155a	2882c
63+50+50	2.17a	225a	347a	229a	3463a	2.14a	5.33a	12.11a	2116a	2998b
113+50+50	2.11a	220a	336a	243a	3452a	2.24a	5.31a	12.22a	2105a	3080a
Min. LSR,LSD	0.10	13.8	21.6	27.9	269.4	0.17	.058	0.73	51.9	54.8
Max. LSR	0.11	14.6	22.7	29.4	283.3	0.17	.061	0.76	54.6	57.6
C.V. %	8.5	11.1	11.4	20.6	14.0	13.5	2.0	10.7	4.4	3.3

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

5/ Soil samples obtained before limestone applications.

6/ Yields obtained after limestone applications.

(1) 38 pounds of nitrogen per acre.

(2) 63 pounds of nitrogen per acre.

(3) 113 pounds of nitrogen per acre.

Table 2: Soil Test Results and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1964

Soil Treatment Limestone	% O.M.	Lb/A P_2O_5	Exchangeable Lbs/A K	Mg.	Ca	N.A.	pHs	C.E.C.	Seed Cotton Yield-Lb/A 1st Pick	Total
None (1)	1.83b-h	244abc	357b-e	233a-e	2967hi	2.00ab	5.27mn	10.83g-j	1661ab	1977ab
None (2)	2.00a-f	251abc	350b-e	180cde	2900hi	2.50a	5.17n	10.83g-j	1496b-f	1908abc
None (3)	1.77b-h	192abc	377abc	287a	2900hi	1.83abc	5.33mn	10.83g-j	1014kl	1470f
1/ 2 Tons (1)	2.07a-d	268ab	360a-e	267ab	3833efg	2.00ab	5.80h-k	13.17c-f	1649ab	2038ab
2 Tons (2)	2.13ab	211abc	327cde	260abc	3400f-i	1.67bcd	5.80h-k	11.67e-i	1564a-d	2028ab
2 Tons (3)	2.17ab	231abc	357b-e	260abc	3467fgh	1.50b-e	5.73jk	11.67e-i	1243hij	1748cde
4 Tons (1)	2.17ab	295ab	387ab	247a-e	4133def	1.00e-h	6.17efg	12.83c-g	1554a-e	1985ab
4 Tons (2)	2.33a	281ab	367a-d	260abc	3833efg	1.17d-g	5.97g-j	12.17d-h	1457b-g	1921abc
4 Tons (3)	2.17ab	279ab	353b-e	240a-e	4433cde	1.17d-g	6.03f-i	13.67cde	1187ijk	1773cde
8 Tons (1)	2.10abc	263abc	333b-e	253a-d	5067c	0.17ij	6.63abc	14.33abc	1480b-f	1921abc
8 Tons (2)	2.13ab	209abc	343b-e	233a-e	4700cd	0.83fgh	6.47bcd	14.00bcd	1363d-i	1855bcd
8 Tons (3)	1.77b-h	213abc	337b-e	253a-d	4967c	0.67ghi	6.60abc	14.67abc	1149jkl	1717de
12 Tons (1)	1.80b-h	231abc	350b-e	220a-e	5200bc	0.00j	6.87a	14.33abc	1564a-d	2008ab
12 Tons (2)	1.60fgh	197abc	307e	220a-e	5900ab	0.00j	6.73ab	15.83ab	1424c-h	1934abc
12 Tons (3)	1.53gh	258abc	320cde	180cde	5967a	0.17ij	6.70ab	16.17a	1215ij	1781cde
2/ 1 Ton (1)	1.90b-g	141c	317de	227a-e	2867hi	1.33c-f	5.77ijk	9.83ij	1712a	2010ab
1 Ton (2)	1.67d-h	200abc	357b-e	260abc	2867hi	1.17d-g	5.90g-k	9.83ij	1705a	2064a
1 Ton (3)	1.70c-h	177bc	333b-e	207a-e	2767hi	1.33c-f	5.87h-k	9.50ij	1310f-j	1850bcd
2 Tons (1)	1.47h	313a	343b-e	193b-e	3333f-i	0.67ghi	6.27def	10.33hij	1498b-f	1916abc
2 Tons (2)	1.53gh	264abc	340b-e	193b-e	3133ghi	0.67ghi	6.27def	9.83ij	1271g-j	1758cde
2 Tons (3)	1.43h	272ab	330b-e	187b-e	3567fgh	1.00e-h	6.07fgh	11.00g-j	963l	1447f
4 Tons (1)	1.90b-g	308a	413a	167e	3833efg	0.83fgh	6.27def	11.50f-j	1478b-f	1880a-d
4 Tons (2)	2.03a-e	269ab	330b-e	173de	3900d-g	0.83fgh	6.40cde	11.67e-i	1437c-h	1898a-d
4 Tons (3)	1.80b-h	243abc	340b-e	173de	4000def	0.50hi	6.37cde	11.67e-i	1129jkl	1641e
3/ 500 Lbs. (1)	1.60fgh	229abc	317de	213a-e	2933hi	1.17d-g	5.67kl	9.83ij	1621abc	1982ab
500 Lbs. (2)	1.63e-h	184bc	310de	260abc	3100ghi	1.50b-e	5.33mn	10.67g-j	1547a-e	2031ab
500 Lbs. (3)	1.67d-h	175bc	323cde	260abc	2567i	1.50b-e	5.47lm	9.33j	1353e-i	1868a-d
Min. LSR,LSD	0.35	104.0	49.3	71.2	723.7	0.54	0.25	1.87	177.2	166.4
Max. LSR	0.41	124.1	58.8	85.0	863.6	0.64	0.30	2.24	211.4	198.6
C.V. %	11.2	26.1	8.5	18.8	11.4	29.5	2.5	9.4	7.5	5.3
LIMESTONE MEANS										
None	1.87abc	229ab	361a	233a	2922e	2.11a	5.26h	10.83cde	1390ab	1785a
2 Tons 1/	2.12ab	237ab	348a	262a	3567cde	1.72ab	5.78f	12.17bcd	1485ab	1938a
4 Tons	2.22a	285a	369a	249a	4133c	1.11b-e	6.06de	12.89bc	1400ab	1893a
8 Tons	2.00abc	228ab	338a	247a	4911b	0.56ef	6.57ab	14.33ab	1331ab	1831a
12 Tons	1.64bc	229ab	326a	207a	5689a	0.06f	6.77a	15.44a	1401ab	1908a
1 Ton 2/	1.76abc	173b	336a	231a	2833e	1.28bcd	5.84ef	9.72e	1576a	1975a
2 Tons	1.48c	283a	338a	191a	3344de	0.78cde	6.20cd	10.39de	1244b	1707a
4 Tons	1.91abc	273a	361a	171a	3911cd	0.72de	6.34bc	11.61cde	1348ab	1807a
500 Lbs. 3/	1.63bc	196b	317a	244a	2867e	1.39bc	5.49g	9.94de	1507ab	1960a
Min. LSR,LSD	0.48	65.4	51.8	86.8	680.8	0.59	0.22	2.18	245.0	246.2
Max. LSR	0.54	74.3	58.9	98.7	73.9	0.67	0.26	2.48	278.5	279.8
C.V. %	25.7	27.6	15.1	38.4	17.9	54.8	3.4	18.3	17.4	13.2
NITROGEN MEANS										
38+50+50 4/	1.87a	255a	353a	224a	3796a	1.02a	6.08a	11.89a	1580a	1969a
63+50+50	1.90a	230a	337a	227a	3748a	1.15a	6.00a	11.83a	1474b	1933a
113+50+50	1.78a	227a	341a	227a	3848a	1.07a	6.02a	12.06a	1174c	1700b
Min. LSR,LSD	0.12	34.7	16.4	23.7	241.2	0.18	.084	0.62	59.1	55.5
Max. LSR	0.12	36.5	17.3	25.0	253.7	0.19	.089	0.66	62.1	58.3
C.V. %	11.2	26.1	8.5	18.8	11.4	29.5	2.5	9.4	7.5	5.3

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

(1) 38 pounds of nitrogen per acre.

(2) 63 pounds of nitrogen per acre.

(3) 113 pounds of nitrogen per acre.

Table 3: Soil Test Results and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1965

Soil Treatment	%	Lb/A	Exchangeable Lbs/A						Seed Cotton Yield-Lb/A	
Limestone	O.M.	P_2O_5	K	Mg.	Ca	N.A.	pHs	C.E.C.	1st Pick	Total
None (1)	2.23a-f	227h-k	417a-f	273a	29671	2.67a	5.43a	11.67g-k	2548h-l	2777fgh
None (2)	2.17b-h	234f-k	423a-e	273a	29671	2.83a	5.33hij	11.83f-k	2617f-l	2864d-h
None (3)	2.27a-e	236f-k	450ab	273a	3233jkl	2.83a	5.37ij	12.67c-i	2726b-k	3050a-f
1/ 2 Tons (1)	2.40a-d	241e-k	427a-e	273a	3833e-i	2.00bc	5.90efg	13.17a-f	2645d-l	2864d-h
2 Tons (2)	2.50ab	253c-j	453a	253a-d	4033e-h	1.67cde	6.07b-e	13.50a-d	2818a-h	3040b-f
2 Tons (3)	2.43abc	257c-i	410a-f	253a-d	3633g-j	2.00bc	5.80e-h	12.67c-i	2879a-f	3188abc
4 Tons (1)	2.57a	284a-d	420a-f	260abc	4233c-f	1.33d-g	6.13b-e	13.33a-e	2489kl	2693gh
4 Tons (2)	2.50ab	282a-d	413a-f	227d-g	4233c-f	1.67cde	6.07b-e	13.67abc	2510jkl	2810e-h
4 Tons (3)	2.50ab	296ab	447abc	227d-g	4167d-g	1.67cde	6.13b-e	13.50a-d	2803a-i	3093a-e
8 Tons (1)	2.20b-g	263b-h	377ef	213fg	4367b-e	1.00fgh	6.50bc	13.33a-e	2703c-l	2915c-g
8 Tons (2)	2.20b-g	286abc	433a-d	233c-g	4867ab	0.83gh	6.50bc	14.33a	2831a-g	3098a-e
8 Tons (3)	2.13c-i	301a	410a-f	220efg	4633a-d	0.83gh	6.60abc	13.83abc	2775a-j	3065a-f
12 Tons (1)	2.00e-i	241e-k	380def	207g	5067a	0.17i	6.87a	14.00abc	2923abc	3129a-d
12 Tons (2)	2.13c-i	254c-j	377ef	207g	4800abc	0.50i	6.73ab	13.67abc	2968abc	3269ab
12 Tons (3)	1.87ghi	211k	367f	240b-f	4767abc	0.83gh	6.63abc	14.17ab	2945abc	3246ab
2/ 1 Ton (1)	1.93e-i	240e-k	393c-f	247a-e	3033kl	2.00bc	5.67g-j	11.00jk	2627f-l	2810e-h
1 Ton (2)	2.07d-i	248d-j	410a-f	240b-f	3233jkl	2.00bc	5.80e-h	11.50h-k	2609f-l	2826d-h
1 Ton (3)	1.93e-i	221ijk	407a-f	220efg	29671	2.00bc	5.53j	10.67k	3009a	3356a
2 Tons (1)	1.83hi	219jk	397b-f	247a-e	3333i-l	1.50c-f	6.00b-g	11.33ijk	2609f-l	2818e-h
2 Tons (2)	1.80i	223ijk	393c-f	233c-g	3434i-l	1.33d-g	6.03b-f	11.50h-k	2912a-d	3175abc
2 Tons (3)	1.90f-i	230g-k	410a-f	247a-e	3434i-l	1.33d-g	6.10b-e	11.33ijk	2943abc	3241ab
4 Tons (1)	2.37a-d	267a-g	397b-f	227d-g	3667f-j	1.33d-g	6.07b-e	12.00e-k	24331	2602h
4 Tons (2)	2.27a-e	275a-e	407a-f	213fg	4167d-g	1.17efg	6.33cd	13.00a-g	2563g-l	2816e-h
4 Tons (3)	2.07d-i	269a-f	417a-f	220efg	3633g-j	1.83bcd	5.97efg	12.17d-j	2530i-l	2770fgh
3/ 500 Lbs. (1)	1.93e-i	220jk	367f	247a-e	3367i-l	2.33ab	5.67g-j	12.17d-j	2632e-l	2831d-h
500 Lbs. (2)	1.93e-i	229h-k	393c-f	273a	3567h-k	2.33ab	5.70f-i	12.83b-h	2905a-e	3195abc
500 Lbs. (3)	1.87ghi	225ijk	407a-f	267ab	3233jkl	2.33ab	5.70f-i	11.83f-k	2999ab	3328ab
Min. LSR,LSD	0.31	31.2	45.4	27.4	506.6	0.54	0.31	1.19	235.0	264.0
Max. LSR	0.37	37.2	54.1	32.7	604.5	0.64	0.37	1.42	280.4	315.0
C.V. %	8.5	7.5	6.6	6.8	7.9	19.4	3.0	5.6	5.1	5.3
LIMESTONE MEANS										
None	2.22ab	232e	430a	273a	3056e	2.78a	5.38d	12.06b-d	2630a	2897a
2 Tons 1/	2.44ab	250a	430a	260a	3833cd	1.89bc	5.92bc	13.11abc	2781a	3030a
4 Tons	2.52a	287a	427a	238a	4211bc	1.56cd	6.11b	13.50ab	2601a	2866a
8 Tons	2.18ab	283a	407ab	222a	4622ab	0.89de	6.53a	13.83a	2770a	3026a
12 Tons	2.00ab	235a	374b	218a	4878a	0.50e	6.74a	13.94a	2946a	3215a
1 Ton 2/	1.98ab	236a	403ab	236a	3078e	2.00bc	5.67	11.06d	2748a	2997a
2 Tons	1.84b	224a	400ab	242a	3400de	1.39cd	6.04b	11.39cd	2821a	3078a
4 Tons	2.23ab	270a	407ab	220a	3822cd	1.44cd	6.12b	12.39a-d	2509a	2729a
500 Lbs. 3/	1.91ab	225a	389ab	262a	3389de	2.33ab	5.69c	12.28a-d	2845a	3118a
Min. LSR,LSD	0.59	66.1	44.6	58.4	573.5	0.66	0.25	1.57	489.4	510.0
Max. LSR	0.68	75.2	50.7	66.3	651.8	0.75	0.28	1.79	556.3	579.7
C.V. %	27.7	26.5	11.0	24.2	15.1	40.0	4.1	12.5	17.9	17.0
NITROGEN MEANS										
38+50+50 4/	2.16a	245a	397b	244a	3763ab	1.59a	6.03a	12.44b	2623c	2827c
63+50+50	2.17a	254a	411ab	239a	3922a	1.59a	6.06a	12.87a	2748b	3010b
113+50+50	2.11a	249a	414a	241a	3744b	1.74a	5.98a	12.54ab	2846a	3148a
Min. LSR,LSD	0.10	10.4	15.1	9.1	168.9	0.18	0.10	0.40	78.3	88.0
Max. LSR	0.11	10.9	15.9	9.6	177.6	0.19	0.11	0.42	82.4	92.5
C.V. %	8.5	7.5	6.6	6.8	7.9	19.4	3.0	5.6	5.1	5.3

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

(1) 38 pounds of nitrogen per acre.
(2) 63 pounds of nitrogen per acre.
(3) 113 pounds of nitrogen per acre.

Table 4: Soil Test Results and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1966

Soil Treatment Limestone	% O.M.	Lb/A P_2O_5	Exchangeable Lbs/A K	Mg.	Ca	N.A.	pHs	C.E.C.	Seed Cotton Yield-Lb/A 1st Pick	Total
None (1)		284fg	457a-d	260abc	2767fgh	2.50bc	5.30j	11.00f-j	1544abc	2171abc
None (2)		313b-f	447a-f	260abc	2733fgh	3.00a	5.17j	11.33e-h	1236f-i	2018a-h
None (3)		298d-g	467ab	253a-d	2833fgh	2.83ab	5.17j	11.67c-g	1249e-i	2046a-h
1/2 Tons (1)		320a-e	463abc	267ab	3500cd	2.67ab	5.67gh	13.17a	1592a	2235a
2 Tons (2)		331a-d	487a	253a-d	3500cd	2.00cd	5.90def	12.33a-e	1470a-g	2235a
2 Tons (3)		324a-e	487a	273a	3467cd	2.50bc	5.67gh	12.83ab	1371a-h	2168abc
4 Tons (1)		339abc	443a-f	247a-e	3967b	1.17fg	6.07d	12.83ab	1475a-f	2143a-d
4 Tons (2)		339abc	460a-d	220e-h	3667bc	1.67def	6.10d	12.50a-d	1271d-i	1924d-h
4 Tons (3)		326a-e	453a-e	240b-f	3867b	1.67def	6.03d	13.33a	1157hi	1888e-h
8 Tons (1)		352a	447a-f	200ghi	4367a	0.83g	6.60abc	13.00a	1358a-h	1965c-h
8 Tons (2)		348ab	440b-g	200ghi	4367a	1.00g	6.53bc	13.33a	1279d-i	1835h
8 Tons (3)		339abc	427b-g	213fgh	4300a	1.00g	6.47c	13.33a	1096i	1600i
12 Tons (1)		328a-e	423b-g	180i	4600a	0.33h	6.80a	13.00a	1350a-h	1982b-h
12 Tons (2)		331a-d	407fg	193hi	4533a	0.17h	6.80a	12.67abc	1317b-i	2010a-h
12 Tons (3)		316a-f	397g	193hi	4367a	0.33h	6.70ab	12.50a-d	1279d-i	2079a-f
2/1 Ton (1)		294d-g	447a-f	247a-e	2800fgh	2.17cd	5.53h	10.67g-k	1564ab	2184abc
1 Ton (2)		279fg	420c-g	220e-h	2567h	2.00cd	5.47i	9.83k	1220ghi	1954c-h
1 Ton (3)		273g	467ab	240b-f	2600gh	2.17cd	5.40i	10.17ijk	1254e-i	2077a-g
2 Tons (1)		305c-g	433b-g	220e-h	2900fg	1.83de	5.90def	10.50h-k	1506a-d	2163abc
2 Tons (2)		292efg	453a-e	227d-g	2967ef	1.33efg	5.80efg	10.17ijk	1152hi	1847gh
2 Tons (3)		292efg	463abc	233c-f	2967ef	1.83de	5.70fgh	10.83f-k	1177hi	1850fgh
4 Tons (1)		324a-e	447a-f	193hi	3233de	1.33efg	6.07d	10.67g-k	1580a	2128a-d
4 Tons (2)		326a-e	437b-g	200ghi	3333d	1.33efg	6.00de	11.17f-i	1437a-g	2061a-h
4 Tons (3)		292efg	420c-g	213fgh	2967ef	1.33efg	5.97de	10.00jk	1493a-e	2179abc
3/500 Lbs. (1)		294d-g	410efg	227d-g	3367cd	1.67def	5.97de	11.50d-h	1539abc	2110a-e
500 Lbs. (2)		341abc	430b-g	247a-e	3433cd	1.67def	5.90def	11.83b-f	1353a-h	2158abc
500 Lbs. (3)		284fg	417d-g	247a-e	3467cd	1.67def	5.90def	11.83b-f	1302c-i	2207ab
Min. LSR,LSD		31.2	39.0	24.5	288.7	0.45	0.19	0.93	212.0	196.5
Max. LSR		37.2	46.6	29.2	344.5	0.53	0.23	1.11	253.0	234.5
C.V. %		5.9	5.3	6.4	5.0	16.4	1.9	4.7	9.3	5.7
LIMESTONE MEANS										
None		298ab	457ab	258a	2778de	2.78a	5.21g	11.33bc	1343a	2078ab
2 Tons 1/		325ab	479a	264a	3489bc	2.39a	5.74e	12.78ab	1478a	2213a
4 Tons		335a	452ab	236ab	3833b	1.50bcd	6.07c	12.89ab	1301a	1985ab
8 Tons		346a	438bc	204bc	4344a	0.94d	6.53b	13.22a	1244a	1800b
12 Tons		325ab	409c	189c	4500a	0.28e	6.77a	12.72ab	1316a	2024ab
1 Ton 2/		282b	444abc	236ab	2656e	2.11ab	5.47f	10.22c	1346a	2072ab
2 Tons		296ab	450ab	227abc	2944de	1.67bc	5.80de	10.50c	1278a	1953ab
4 Tons		314ab	434bc	202bc	3178cd	1.33cd	6.01cd	10.61c	1503a	2122ab
500 Lbs. 3/		306ab	419bc	240ab	3422bc	1.67bc	5.92cde	11.72abc	1398a	2158ab
Min. LSR,LSD		45.0	34.5	40.6	438.7	0.64	0.20	1.45	287.2	344.6
Max. LSR		51.2	39.2	46.1	498.7	0.73	0.23	1.65	326.4	391.7
C.V. %		14.3	7.8	17.8	12.7	39.2	3.4	12.4	21.2	16.9
NITROGEN MEANS										
38+50+50 4/		316a	441a	227a	3500a	1.61a	5.99a	11.81a	1501a	2120a
63+50+50		322a	442a	224b	3456a	1.57a	5.96a	11.69a	1304b	2005b
113+50+50		305b	444a	234a	3426a	1.70a	5.89b	11.83a	1264b	2010b
Min. LSR,LSD		10.4	13.0	8.2	96.2	0.15	.064	0.31	70.7	65.5
Max. LSR		10.9	13.7	8.6	101.2	0.16	.068	0.32	74.3	68.9
C.V. %		5.9	5.3	6.4	5.0	16.4	1.9	4.7	9.3	5.7

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

(1) 38 pounds of nitrogen per acre.
(2) 63 pounds of nitrogen per acre.
(3) 113 pounds of nitrogen per acre.

Table 5: Soil Test Results and Seed Cotton Yields on Tiptonville Silt Loam Soil 1967

Soil Treatment	%	Lb/A	Exchangeable Lbs/A						Seed Cotton Yield-Lb/A	
Limestone	O.M.	P_2O_5	K	Mg.	Ca	N.A.	pHs	C.E.C.	1st Pick	Total
None (1)	2.23d-g	331ijk	470bcd	220abc	3133ghi	2.17bc	5.50i	11.50efg	1819ab	2308abc
None (2)	2.27c-f	348f-k	513ab	233ab	3167ghi	2.83a	5.23jk	12.33a-f	1814ab	2357ab
None (3)	2.33a-e	330ijk	517ab	240a	3167ghi	2.83a	5.17k	12.33a-f	2324a	2846a
1/ 2 Tons (1)	2.30b-f	358d-k	507abc	240a	3700b-e	1.83c-f	5.80gh	12.67a-e	1722b	2176bc
2 Tons (2)	2.30b-f	354e-k	530ab	220abc	3933bcd	1.67def	5.83gh	13.00abc	1962ab	2370ab
2 Tons (3)	2.50a-d	354e-k	517ab	240a	3533d-g	2.50ab	5.47ij	12.83a-d	1740b	2156bc
4 Tons (1)	2.57ab	382a-f	463bcd	213abc	4000bc	1.33fgh	6.07efg	12.83a-d	1814ab	2237bc
4 Tons (2)	2.60a	361c-j	493a-d	207bcd	3933bcd	1.50efg	6.00fg	12.83a-d	1796ab	2273bc
4 Tons (3)	2.57ab	376a-g	517ab	200cde	4000bc	1.33fgh	6.00fg	13.00abc	1575b	2038bc
8 Tons (1)	2.33a-e	399ab	467bcd	173ef	4567a	0.501-1	6.70bc	13.17ab	1514b	1886bc
8 Tons (2)	2.53abc	406a	510abc	207bcd	4700a	0.33jkl	6.67bc	13.50a	1595b	1906bc
8 Tons (3)	2.23d-g	395abc	527ab	173ef	4500a	0.67ijk	6.50cd	13.33a	1432b	1743c
12 Tons (1)	1.97ghi	388a-e	437de	167f	4867a	0.001	7.07a	13.33a	1559b	1962bc
12 Tons (2)	1.97ghi	393a-d	470bcd	167f	4900a	0.001	7.03a	13.50a	1554b	1967bc
12 Tons (3)	2.03f-i	375a-g	470bcd	167f	4500a	0.17kl	6.87ab	12.67a-e	1475b	1855bc
2/ 1 Ton (1)	1.93hij	324k	447cd	220abc	3000hi	2.00b-e	5.53i	11.00g	1817ab	2280bc
1 Ton (2)	2.13e-h	343g-k	493a-d	220abc	3000hi	2.00b-e	5.57hi	11.17fg	1651b	2196bc
1 Ton (3)	2.03f-i	350f-k	543a	213abc	28671	2.33abc	5.40ijk	11.00g	1666b	2283bc
2 Tons (1)	1.90hij	333h-k	463bcd	213abc	3267f-i	1.50efg	5.83gh	11.00g	1779ab	2168bc
2 Tons (2)	1.97ghi	341g-k	523ab	207bcd	3200ghi	1.33fgh	5.83gh	10.83g	1580b	2013bc
2 Tons (3)	2.10e-i	328jk	530ab	220abc	3167ghi	2.00b-e	5.63hi	11.50efg	1536b	1906bc
4 Tons (1)	2.17e-h	367b-h	467bcd	180def	3467e-g	1.50efg	5.93fg	11.50efg	1722b	2010bc
4 Tons (2)	2.33a-e	361c-j	490a-d	213abc	3633c-f	1.33fgh	6.03fg	11.83c-g	1661b	2005bc
4 Tons (3)	2.37a-e	388a-e	503abc	200cde	3400e-h	2.00b-e	5.57hi	11.83c-g	1603b	1919bc
3/ 500 Lbs. (1)	1.67j	365b-i	373f	207bcd	3733b-e	1.00ghi	6.30de	11.67d-g	1725b	2148bc
500 Lbs. (2)	1.83ij	326jk	383ef	200cde	4067b	0.501-1	6.47cd	12.00b-g	1817ab	2352ab
500 Lbs. (3)	2.03f-i	324k	467bcd	227abc	3733b-e	0.83hij	6.20ef	11.67d-g	1626b	2194bc
Min. LSR,LSD	0.25	30.3	56.2	26.0	371.5	0.47	0.24	1.03	485.5	491.2
Max. LSR	0.30	36.2	67.0	31.0	443.2	0.56	0.29	1.23	579.3	586.2
C.V. %	6.9	5.0	6.9	7.5	5.9	19.7	2.4	5.0	17.0	13.7
LIMESTONE MEANS										
None	2.28ab	336b	500a	231a	3156cd	2.61a	5.30g	12.06abc	1986a	2504a
2 Tons 1/	2.37ab	356ab	518a	233a	3722b	2.00b	5.70ef	12.83ab	1808ab	2234ab
4 Tons	2.58a	373ab	491a	207ab	3978b	1.39c	6.02d	12.89ab	1728ab	2183ab
8 Tons	2.37ab	400a	501a	184bc	4589a	0.50de	6.62b	13.33a	1514b	1845b
12 Tons	1.99bc	385ab	459ab	167c	4756a	0.06e	6.99a	13.17ab	1530b	1928b
1 Ton 2/	2.03bc	339b	494a	218ab	2956d	2.11ab	5.50fg	11.06c	1711ab	2253ab
2 Tons	1.99bc	334b	506a	213ab	3211cd	1.61bc	5.77e	11.11c	1632ab	2029ab
4 Tons	2.29ab	372ab	487a	198abc	3500bc	1.61bc	5.84de	11.72bc	1662ab	1978b
500 Lbs. 3/	1.84c	338b	408b	211ab	3844b	0.78d	6.32c	11.78bc	1722ab	2231ab
Min. LSR,LSD	0.37	47.3	69.6	35.8	452.9	0.53	0.24	1.35	353.7	465.9
Max. LSR	0.42	53.8	79.1	40.7	514.8	0.60	0.27	1.53	402.0	529.6
C.V. %	16.9	13.2	14.4	17.3	12.1	37.6	4.0	11.0	20.8	21.9
NITROGEN MEANS										
38+50+50 4/	2.12b	361a	455c	204a	3748ab	1.31b	6.08a	12.07a	1719a	2131a
63+50+50	2.21a	359a	490b	208a	3837a	1.28b	6.07a	12.33a	1715a	2160a
113+50+50	2.24a	358a	510a	209a	3652b	1.63a	5.87b	12.24a	1664a	2104a
Min. LSR,LSD	.084	10.1	18.7	8.7	123.8	0.16	.080	0.34	161.8	163.7
Max. LSR	.088	10.6	19.7	9.1	130.2	0.16	.084	0.36	170.2	172.2
C.V. %	6.9	5.0	6.9	7.5	5.9	19.7	2.4	5.0	17.0	13.7

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

(1) 38 pounds of nitrogen per acre.

(2) 63 pounds of nitrogen per acre.

(3) 113 pounds of nitrogen per acre.

Table 6: Soil Test Results and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1968

Soil Treatment	%	Lb/A	Exchangeable Lbs/A						Seed Cotton Yield-Lb/A	
Limestone	O.M.	P_2O_5	K	Mg.	Ca	N.A.	pHs	C.E.C.	1st Pick	Total
None (1)	2.33a-f	317cd	563a-d	227a	3367efg	2.50a	5.50hi	12.60a-d	2033i	2413j
None (2)	2.30a-f	349a-d	577a-d	257a	3667d-g	2.50a	5.43i	13.47a-d	2186e-i	2660hij
None (3)	2.27a-f	382ab	613a	217a	3833c-g	2.33ab	5.60ghi	13.60a-d	2181e-i	2762e-i
1/ 2 Tons (1)	2.20b-f	341a-d	590abc	233a	3500efg	2.33ab	5.57ghi	12.83a-d	2255d-i	2739f-i
2 Tons (2)	2.33a-f	337a-d	577a-d	247a	3533d-g	2.33ab	5.60ghi	12.17a-d	2474a-e	2956b-h
2 Tons (3)	2.37a-e	307d	557a-d	280a	2833g	2.50a	5.63f-i	11.47cd	2395a-g	2996b-g
4 Tons (1)	2.63ab	345a-d	543b-e	233a	4000b-f	1.67a-e	6.03c-i	13.43a-d	2064hi	2627j
4 Tons (2)	2.40a-d	345a-d	593ab	237a	4033b-f	1.67a-e	6.07c-h	13.50a-d	2176e-i	2808e-i
4 Tons (3)	2.73a	349a-d	590abc	227a	4633a-d	1.50a-e	6.17c-g	14.13abc	2260c-i	2928c-i
8 Tons (1)	2.23b-f	351a-d	553a-d	233a	4200a-e	1.17b-f	6.30a-e	13.37a-d	2171e-i	2749f-i
8 Tons (2)	2.53abc	355a-d	567a-d	267a	3967b-f	1.50a-e	6.03c-i	13.23a-d	2339b-i	2956b-h
8 Tons (3)	2.23b-f	369abc	563a-d	187a	4633a-d	0.50fg	6.60abc	13.60a-d	2316b-i	2943b-i
12 Tons (1)	1.90ef	353a-d	533b-e	200a	4467a-e	0.83c-g	6.23b-f	13.50a-d	2171e-i	2777e-i
12 Tons (2)	2.20b-f	355a-d	520de	177a	5233a	0.17fg	6.80ab	14.67a	2105ghi	2813e-i
12 Tons (3)	2.00def	388a	533b-e	213a	5000ab	0.00g	6.87a	14.10abc	2359b-h	3017b-f
2/ 1 Ton (1)	1.93def	305d	533b-e	247a	3533d-g	2.17ab	5.63f-i	12.70a-d	2298b-i	2742f-i
1 Ton (2)	1.93def	343a-d	567a-d	230a	3600d-g	2.00abc	5.63f-i	12.70a-d	2561abc	3119a-d
1 Ton (3)	1.93def	347a-d	577a-d	277a	3600d-g	2.00abc	5.60ghi	12.90a-d	2691a	3371a
2 Tons (1)	2.03def	341a-d	527cde	260a	3400efg	2.00abc	5.80e-i	12.50a-d	2461a-f	2854d-i
2 Tons (2)	2.03def	335bcd	553a-d	240a	3033fg	2.00abc	5.63f-i	11.30d	2579ab	3129a-d
2 Tons (3)	1.87f	349a-d	527cde	203a	3600d-g	1.33a-e	6.03c-i	11.87bcd	2693a	3221ab
4 Tons (1)	2.23b-f	349a-d	573a-d	240a	3067fg	2.00abc	5.60ghi	11.40d	2100ghi	2561j
4 Tons (2)	2.27a-f	364abc	527cde	200a	4000b-f	1.17b-f	6.17c-g	12.67a-d	2173e-i	2709ghi
4 Tons (3)	2.10c-f	383ab	567a-d	207a	3633d-g	1.83a-d	5.90d-i	12.47a-d	2163f-i	2650ij
3/ 500 Lbs. (1)	2.07c-f	384ab	530b-e	243a	4400a-e	1.17b-f	6.23b-f	13.83a-d	2222d-i	2647ij
500 Lbs. (2)	1.97def	368abc	553a-d	187a	4867abc	0.67d-g	6.47a-d	14.33ab	2512a-d	3047b-e
500 Lbs. (3)	1.90ef	355a-d	490e	200a	4400a-e	0.83c-g	6.30a-e	13.33a-d	2461a-f	3147abc
Min LSR,LSD	0.40	43.9	54.0	90.2	947.8	1.01	0.52	2.24	260.2	251.7
Max. LSR	0.48	52.3	64.5	107.6	1131.0	1.20	0.62	2.68	310.5	300.4
C.V. %	11.0	7.5	5.8	23.5	14.4	38.0	5.2	10.3	6.7	5.2
LIMESTONE MEANS										
None	2.30ab	350a	584a	233a	3622bc	2.44a	5.51d	13.22a	2134a	2612a
2 Tons 1/	2.30ab	328a	574a	253a	3289c	2.39a	5.60d	12.16a	2375a	2897a
4 Tons	2.59a	346a	576a	232a	4222abc	1.61ab	6.09bc	13.69a	2167a	2788a
8 Tons	2.33ab	358a	561a	229a	4267ab	1.06bc	6.31ab	13.40a	2275a	2883a
12 Tons	2.03b	366a	529a	197a	4900a	0.33c	6.63a	14.09a	2212a	2869a
1 Ton 2/	1.93b	332a	559a	251a	3578bc	2.06a	5.62d	12.77a	2517a	3077a
2 Tons	1.98b	342a	536a	234a	3344bc	1.78ab	5.82cd	11.89a	2578a	3068a
4 Tons	2.20ab	365a	556a	216a	3567bc	1.67ab	5.89cd	12.18a	2145a	2640a
500 Lbs. 3/	1.98b	369a	524a	213a	4556a	0.89bc	6.33ab	13.83a	2399a	2947a
Min. LSR,LSD	0.48	43.8	67.2	54.1	846.1	0.86	0.38	2.27	490.5	508.0
Max. LSR	0.54	49.3	76.4	61.5	961.7	0.97	0.43	2.58	557.5	577.5
C.V. %	21.9	12.5	12.1	23.7	21.6	54.2	6.3	17.4	21.2	17.7
NITROGEN MEANS										
38+50+50 4/	2.17a	343b	550a	235a	3770a	1.76a	5.88b	12.91a	2197b	2679c
63+50+50	2.22a	350a	559a	227a	3993a	1.56a	5.98a	13.11a	2345a	2911b
113+50+50	2.16a	359a	557a	224a	4019a	1.43a	6.08a	13.05a	2391a	3004a
Min. LSR,LSD	0.13	14.6	18.0	30.1	315.9	0.34	0.17	0.75	86.8	83.9
Max. LSR	0.14	15.4	18.9	31.6	332.2	0.35	0.18	0.79	91.2	88.2
C.V. %	11.0	7.5	5.8	23.5	14.4	38.0	5.2	10.3	6.7	5.2

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

(1) 38 pounds of nitrogen per acre.
(2) 63 pounds of nitrogen per acre.
(3) 113 pounds of nitrogen per acre.

Table 7: Soil Test Results and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1969

Soil Treatment	%	Lb/A	Exchangeable Lbs/A						Seed Cotton Yield-Lb/A	
Limestone	O.M.	P_2O_5	K	Mg.	Ca	N.A.	pHs	C.E.C.	1st Pick	Total
None (1)	2.10c-f	213c-f	365b-f	347ab	3367d-h	2.83ab	5.43mn	13.20a-h	1809ij	2232k
None (2)	2.13c-f	235a-f	397b-e	343ab	3167fgh	3.00a	5.43mn	12.87a-i	1954e-j	2464e-j
None (3)	2.47abc	245a-d	350c-h	303a-e	3200fgh	3.00a	5.33n	12.70a-j	1934f-j	2576c-h
1/2 Tons (1)	2.40a-d	242a-e	313e-h	300a-e	3633c-g	2.33bcd	5.73f-j	13.07a-i	2066b-h	2484e-j
2 Tons (2)	2.43abc	235a-f	353c-g	290b-g	3733c-f	2.33bcd	5.70g-j	13.37a-g	2107b-g	2637b-g
2 Tons (3)	2.53ab	250ab	337d-h	260c-h	3500d-h	2.33bcd	5.63i-l	12.57a-j	2209ab	2805ab
4 Tons (1)	2.57ab	260a	417abc	250d-h	4367abc	1.83def	5.97d	14.33a	1929f-j	2367h-k
4 Tons (2)	2.73a	262a	453a	220gh	4300abc	1.83def	5.97d	14.07abc	1962d-j	2520d-i
4 Tons (3)	2.63a	252ab	433ab	237e-h	4300abc	1.83def	5.97d	14.13ab	2072b-h	2673b-e
8 Tons (1)	2.10c-f	242a-e	317e-h	223gh	4500ab	1.17g	6.37abc	13.77a-e	2021b-h	2540d-h
8 Tons (2)	2.23b-e	257ab	373b-e	230fgh	4333abc	1.33fg	6.23c	13.60a-f	2176abc	2731a-d
8 Tons (3)	1.97e-h	243a-e	293fgh	207h	4667ab	1.17a	6.33bc	14.10ab	1880hij	2637b-g
12 Tons (1)	1.60h	205f	278h	220gh	3967b-e	0.83g	6.43ab	12.03d-k	2000c-h	2449f-j
12 Tons (2)	1.63h	203f	283gh	223gh	4733a	0.83g	6.53a	13.97a-d	2128b-f	2675b-e
12 Tons (3)	1.70gh	213c-f	293fgh	210h	4100a-d	0.83g	6.50ab	12.33b-j	2214ab	2803ab
2/1 Ton (1)	1.83fgh	205f	347c-h	313abc	3033fgh	2.67abc	5.50k-n	12.00e-k	1827ij	2291jk
1 Ton (2)	1.87e-h	215c-f	308e-h	293b-f	3400d-h	2.83ab	5.47l-n	12.97a-i	2122b-f	2658b-f
1 Ton (3)	1.80fgh	208ef	347c-h	363a	3200fgh	2.83ab	5.47l-n	12.83a-i	2036b-h	2772abc
2 Tons (1)	1.70gh	202f	317e-h	270c-h	2933gh	2.00de	5.90def	10.871k	1998c-i	2423g-k
2 Tons (2)	1.87e-h	208ef	310e-h	240e-h	3167fgh	2.00de	5.93de	11.33h-k	2186abc	2737a-d
2 Tons (3)	1.87e-h	212def	293fgh	240e-h	3133fgh	2.00de	5.83d-h	11.231jk	2344a	2895a
4 Tons (1)	2.03d-g	248abc	340d-h	240e-h	3500d-h	1.67ef	5.87d-g	11.90e-k	1768j	2291jk
4 Tons (2)	2.03d-g	248abc	360c-f	220gh	3433d-h	1.67ef	5.97d	11.57g-k	1929f-j	2479e-j
4 Tons (3)	2.03d-g	235a-f	343d-h	203h	2833h	2.00de	5.83d-h	10.40k	1906g-j	2568c-h
3/500 Lbs. (1)	1.90e-h	208ef	308e-h	327abc	3300d-h	2.33bcd	5.67h-k	12.37b-j	1906g-j	2321ijk
500 Lbs. (2)	1.63h	230a-f	325d-h	287b-g	3200fgh	2.17cde	5.77e-i	11.80f-k	2151a-e	2665b-f
500 Lbs. (3)	1.90e-h	222b-f	295fgh	300a-e	3267e-h	2.33bcd	5.57j-m	12.13c-k	2168a-d	2770abc
Min. LSR,LSD	0.34	29.6	62.6	59.3	649.3	0.45	0.17	1.64	177.0	185.4
Max. LSR	0.40	35.4	74.7	70.8	774.8	0.53	0.20	1.96	211.2	221.2
C.V. %	9.7	7.7	11.0	13.3	10.6	13.3	1.7	7.7	5.2	4.3
LIMESTONE MEANS										
None	2.23abc	231a	371ab	331a	3244c	2.94a	5.40e	12.92ab	1899a	2424a
2 Tons 1/	2.46ab	242a	334ab	283ab	3622bc	2.33ab	5.69cd	13.00ab	2128a	2642a
4 Tons	2.64a	258a	434a	236ab	4322ab	1.83bc	5.97b	14.18a	1987a	2520a
8 Tons	2.10abc	247a	328ab	220b	4500a	1.22cd	6.31a	13.82ab	2026a	2636a
12 Tons	1.64c	207a	285b	218b	4267ab	0.83d	6.49a	12.78ab	2114a	2642a
1 Ton 2/	1.83bc	209a	334ab	323ab	3211c	2.78a	5.48de	12.60ab	1995a	2573a
2 Tons	1.81bc	207a	307b	250ab	3078c	2.00b	5.89bc	11.14b	2176a	2685a
4 Tons	2.03abc	244a	348ab	221b	3256c	1.78bc	5.89bc	11.29ab	1868a	2446a
500 Lbs. 3/	1.81bc	220a	309b	304ab	3256c	2.28ab	5.67cd	12.10ab	2075a	2585a
Min. LSR,LSD	0.64	55.2	99.3	95.8	774.4	0.72	0.21	2.66	414.9	376.4
Max. LSR	0.72	62.7	112.8	108.9	880.2	0.82	0.24	3.02	471.6	427.9
C.V. %	30.8	24.0	29.3	36.1	21.3	36.0	3.6	21.0	20.4	14.6
NITROGEN MEANS										
38+50+50 4/	2.03a	225a	334a	277a	3622a	1.96a	5.87a	12.61a	1925b	2378c
68+50+50	2.06a	233a	351a	261a	3719a	2.00a	5.89a	12.84a	2079a	2618b
113+50+50	2.10a	231a	332a	258a	3578a	2.04a	5.83a	12.49a	2085a	2722a
Min. LSR,LSD	0.11	9.9	20.9	19.8	216.4	0.15	.056	0.55	59.0	61.8
Max. LSR	0.12	10.4	21.9	20.8	227.6	0.16	.059	0.57	62.0	65.0
C.V. %	9.7	7.7	11.0	13.3	10.6	13.3	1.7	7.7	5.2	4.3

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

(1) 38 pounds of nitrogen per acre.

(2) 63 pounds of nitrogen per acre.

(3) 113 pounds of nitrogen per acre.

Table 8: Soil Test Results and Seed Cotton Yields on a Tiptonville Silt Loam Soil 1970

Soil Treatment	%	Lb/A	Exchangeable Lbs/A						Seven Year Summary[5]	
Limestone	O.M.	P_2O_5	K	Mg.	Ca	N.A.	pHs	C.E.C.	1st Pick	Total
None (1)	2.33ab	263a-e	460a	343a	3467d-h	2.67bc	5.60de	13.33a-e	1943b-e	2386jkl
None (2)	2.10b-e	275a-d	412a-f	320a-e	3133f-i	2.83ab	5.43ef	12.53b-f	1889d-g	2432g-k
None (3)	2.03b-f	257a-e	413a-f	327a-d	3400e-i	3.33a	5.27f	13.73a-e	1922b-f	2513c-h
1/ 2 Tons (1)	1.97c-f	252a-e	383a-f	340ab	3667c-h	2.50bcd	5.67b-e	13.57a-e	2026ab	2495d-j
2 Tons (2)	2.17a-d	275abc	430abc	300a-h	4000b-g	2.33b-e	5.70b-e	14.13ab	2100a	2624abc
2 Tons (3)	2.03b-f	285ab	400a-f	290a-i	3733c-h	2.50bcd	5.67b-e	13.53a-e	2020abc	2608a-d
4 Tons (1)	2.47a	292a	447ab	307a-g	4167b-e	1.67ef	5.97b	13.93a-d	1934b-e	2432g-k
4 Tons (2)	2.13a-d	280abc	380b-f	257f-i	4033b-f	1.83def	5.97b	13.43a-e	1886d-g	2451f-k
4 Tons (3)	2.33ab	280abc	427a-d	253ghi	3767c-h	1.83def	5.93b	13.33a-e	1879d-g	2505d-h
8 Tons (1)	2.03b-g	278abc	407a-f	237i	4533abc	0.50g	6.60a	13.33a-e	1907c-g	2421g-k
8 Tons (2)	2.23abc	278abc	383a-f	280c-i	4800ab	0.67g	6.53a	14.33ab	1969bcd	2504d-i
8 Tons (3)	2.00b-f	276abc	377b-f	243hi	5300a	0.50g	6.53a	15.23a	1816fg	2401h-k
12 Tons (1)	1.90c-f	278abc	350def	260f-i	4333bcd	0.50g	6.60a	12.87a-f	1970bcd	2468e-j
12 Tons (2)	1.73e-g	267a-e	377b-f	267e-i	4800ab	0.33g	6.70a	13.93a-d	1965bcd	2552b-f
12 Tons (3)	1.80d-g	253a-e	357c-f	247hi	4367bc	0.33g	6.77a	12.70b-f	1959bcd	2568b-f
2/ 1 Ton (1)	1.83d-g	230e	407a-f	313a-f	2567i	2.33b-e	5.57de	10.60f	2005abc	2462e-j
1 Ton (2)	1.93c-f	244b-e	423a-e	300a-h	3100ghi	2.50bcd	5.60de	12.03b-f	1988a-d	2553b-f
1 Ton (3)	1.97c-f	238cde	427a-d	333a-d	3000hi	2.33b-e	5.63cde	11.80c-f	1994a-d	2690a
2 Tons (1)	1.73e-g	231e	373b-f	277d-i	3267f-i	2.00c-f	5.70b-e	11.80c-f	2010abc	2470e-j
2 Tons (2)	1.77e-g	243cde	377b-f	300a-h	3467d-h	1.83def	5.90bc	12.23b-f	1949b-e	2521c-g
2 Tons (3)	1.70fg	250a-e	373b-f	267e-i	2967hi	2.50bcd	5.67b-e	11.50ef	1965bcd	2527c-g
4 Tons (1)	2.17a-d	257a-e	380b-f	283a-i	3333e-i	1.67ef	5.80bcd	11.70def	1844efg	22921
4 Tons (2)	1.90c-f	258a-e	347ef	280c-i	3067hi	1.33f	5.97b	10.63f	1883d-g	2389i-l
4 Tons (3)	1.97c-f	255a-e	343f	283a-i	3233f-i	1.67ef	5.77bcd	11.37ef	1803g	2345k-l
3/ 500 Lbs. (1)	1.83d-g	233de	367c-f	327a-d	3733c-h	2.00c-f	5.80bcd	13.17a-e	1975b-d	2412g-k
500 Lbs. (2)	1.93c-f	254a-e	393a-f	337abc	3733c-h	1.83def	5.90bc	13.07a-e	2089a	2647ab
500 Lbs. (3)	1.50g	257a-e	390a-f	307a-g	3233f-i	2.33b-e	5.47ef	12.20b-f	2037ab	2688a
Min. LSR.LSD	0.31	35.1	66.4	48.1	767.2	0.60	0.26	2.01	95.3	96.4
Max. LSR	0.37	41.8	79.2	57.3	915.5	0.72	0.31	2.39	119.4	120.8
C.V. %	9.3	8.0	10.1	9.8	12.3	20.0	2.6	9.3	8.1	6.4
					LIMESTONE MEANS					
None	2.16a	265a	428a	330a	3333cde	2.94a	5.43d	13.20abc	1918ab	2444ab
2 Tons 1/	2.06a	271a	404abc	310a	3800cd	2.44ab	5.68cd	13.74ab	2049a	2576a
4 Tons	2.31a	284a	418ab	272a	3989bc	1.78bc	5.96b	13.57abc	1899ab	2462ab
8 Tons	2.09a	277a	389abc	253a	4878a	0.56d	6.56a	14.30a	1897ab	2442ab
12 Tons	1.81a	266a	361bc	258a	4500ab	0.39d	6.69a	13.17abc	1965ab	2530a
1 Ton 2/	1.91a	238a	419ab	316a	2889e	2.39ab	5.60cd	11.48bc	1996ab	2569a
2 Tons	1.73a	241a	374abc	281a	3233de	2.11bc	5.76bc	11.84bc	1974ab	2506ab
4 Tons	2.01a	257a	357c	282a	3211de	1.56c	5.84bc	11.23c	1843b	2342b
500 Lbs. 3/	1.76a	248a	383abc	323a	3567cde	2.06bc	5.72bc	12.81abc	2034a	2583a
Min. LSR,LSD	0.58	42.7	52.3	82.4	644.8	0.64	0.23	2.14	134.9	149.1
Max. LSR	0.66	48.6	59.5	93.7	732.9	0.73	0.27	2.43	158.8	175.5
C.V. %	29.2	16.4	13.3	28.3	17.4	35.5	4.0	16.7	19.8	17.1
					NITROGEN MEANS					
38+50+50 4/	2.03a	257a	397a	299a	3674a	1.76a	5.92ab	12.70a	1957ab	2426b
63+50+50	1.99a	264a	391a	293a	3793a	1.72a	5.97a	12.93a	1969a	2519a
113+50+50	1.93a	261a	390a	283a	3667a	1.93a	5.86b	12.82a	1933b	2538a
Min. LSR,LSD	0.10	11.7	22.1	16.0	255.7	0.20	.085	0.67	31.8	32.1
Max. LSR	0.11	12.3	23.3	16.8	268.9	0.21	.090	0.70	33.5	33.9
C.V. %	9.3	8.0	10.1	9.8	12.3	20.0	2.6	9.3	8.1	6.4

1/ Agriculture grade, calcium carbonate limestone from Jonesboro, Illinois applied April 1963.

2/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied April 1963.

3/ Fine lime (less than 100 mesh) calcium carbonate from Ste. Genevieve, Missouri applied annually.

4/ Fertilizer applied annually ($N+P_2O_5+K_2O$).

5/ Cotton was not produced on these plots in 1970.

(1) 38 pounds of nitrogen per acre.

(2) 63 pounds of nitrogen per acre.

(3) 113 pounds of nitrogen per acre.

Table 9: Seven Year Summary of Limestone and Nitrogen Experiment on the Tiptonville Silt Loam Soil at the Portageville Field.

Limestone[1]	Seven Year Average Seed Cotton Yield (Pounds/Acre) First Picking	Total	pHs Initial (1963)	4 Years (1966)	8 Years (1970)
		LIMESTONE SUMMARY			
None	1918 ab	2444 ab	5.3 a	5.2 g	5.4 d
2 T Agricultural	2049 a	2576 a	5.3 a	5.7 e	5.7 cd
4 T	1899 ab	2462 ab	5.3 a	6.1 c	6.0 b
8 T	1897 ab	2442 ab	5.4 a	6.5 b	6.6 a
12 T	1965 ab	2530 a	5.3 a	6.8 a	6.7 a
1 T Fine Lime[2]	1996 ab	2569 a	5.3 a	5.5 f	5.6 cd
2 T	1974 ab	2506 ab	5.3 a	5.8 de	5.8 bc
4 T	1843 b	2342 b	5.3 a	6.0 cd	5.8 bc
500 # Fine Lime[3] (Annually)	2034 a	2583 a	5.4 a	5.9 cde	5.7 be
Min L.S.R. (L.S.D. .05)	135	149	0.13	0.20	0.23
Max L.S.R.	159	176	0.15	0.23	0.27
C.V. %	19.8	17.1	2.5	3.4	4.0
		NITROGEN SUMMARY			
38+50+50	1957 ab	2426 b	5.3 a	6.0 a	5.9 ab
63+50+50	1969 a	2519 a	5.3 a	6.0 a	6.0 a
113+50+50	1933 b	2538 a	5.3 a	5.9 b	5.8 b
Min L.S.R. (L.S.D. .05)	32	32	0.06	0.06	0.09
Max L.S.R.	34	34	0.06	0.07	0.09
C.V. %	8.1	6.4	2.0	1.9	2.6

1/ Calcium carbonate agricultural limestone from Jonesboro, Illinois applied April 1963 only. 13 N + 50 P_2O_5 + 50 K_2O applied annually plus additional nitrogen sidedressed.

2/ Calcium carbonate agricultural fine lime, less than 100 mesh, from Ste. Genevieve, Missouri applied 1963 only.

3/ Calcium carbonate agricultural fine lime, less than 100 mesh, from Ste. Genevieve, Missouri, banded annually near row after emergence.

Table 10: Change in Soil Test Values from Initial Soil Test in 1963 and Final Soil Test in 1970.

Soil Treatment[1]	% O.M.	Lb/A P_2O_5	Exchangeable Lbs/A K	Mg	Ca	N.A.	pHs	C.E.C.
			LIMESTONE SUMMARY					
No Treatment	-.06	+29	+109	+128	-123	+0.5	+0.1	+1.0
2 Tons[2]	-.38	+35	+ 52	+ 37	-133	+0.2	+0.4	+0.24
4 Tons[2]	-.21	+13	+ 72	+ 28	+111	-0.7	+0.7	+0.01
8 Tons[2]	-.09	+35	+ 38	0	+722	-1.5	+1.2	+0.30
12 Tons[2]	-.19	+83	+ 17	+ 16	+867	-1.9	+1.4	+0.45
1 Ton [3]	-.07	+25	+ 98	+ 58	+ 11	+0.3	+0.3	+0.81
2 Tons[3]	-.11	+63	+ 30	+ 41	+444	+0.2	+0.5	+1.45
4 Tons[3]	-.22	+27	- 27	+118	-133	-0.6	+0.5	-0.44
500# Fine Lime[3] (Annually)	-.15	+31	+ 87	+ 23	+778	+0.1	+0.3	+2.25
Mean	-.16	+38	+ 53	+ 50	+283	-0.4	+0.6	+0.67
			NITROGEN SUMMARY					
Lbs. Nitrogen/A								
38	-.13	+34	+ 61	+ 45	+304	-0.44	+0.63	+0.63
63	-.18	+39	+ 44	+ 64	+330	-0.42	+0.64	+0.82
113	-.18	+41	+ 54	+ 40	+215	-0.31	+0.55	+0.60
Mean	-.16	+38	+ 53	+ 50	+283	-0.38	+0.61	+0.68

1/ All plots 13 N + 50 P_2O_5 + 50 K_2O applied annually as starter plus additional nitrogen sidedressed. Limestone applied broadcast and plowed down after obtaining initial soil samples.

2/ Calcium carbonate limestone - Agricultural grade from Jonesboro, Illinois applied 1963 only.

3/ Calcium carbonate limestone - Fine lime (less than 100 mesh) from Ste. Genevieve, Missouri. Annual application banded near row after emergence.