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RESPONSE of CORN to LIME in Field EXPERIMENTS on ALABAMA SOILS

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RESPONSE of CORN to LIME in FIELD EXPERIMENTS on ALABAMA SOILS

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CORN HAS BEEN one of the most extensively grown crops in Alabama and the Southeastern United States for many years even though average yields have been generally low.

However, improved hybrids, higher fertilizer rates (especially nitrogen) and thicker stands have resulted in considerably higher yields in recent years when moisture was adequate. Simultaneously with these changes has been the abandonment of cropping systems in which corn was grown in rotation with legumes. These new farming practices, including the use of high rates of acid-forming nitrogen fertilizers, require a new evaluation of liming needs for corn.

Field experiments with corn that are more than 15 years old are of little value in determining the best liming program for today. For example, during the 1930's and 1940's the recommended practice was to grow corn following a legume in the rotation, the legume supplying the nitrogen for corn. Because most legumes are more sensitive to low soil pH than is corn, the best liming program was one best suited for legumes.

A summary of liming experiments with corn and other crops between 1930 and 1955 in Alabama was published in 1956[1]. Most of those experiments were with corn in rotation with vetch, crimson clover, or lespedeza and were not very useful in defining the relationship between soil pH and corn yield. What sometimes appeared to be increases in corn yields resulting directly from higher soil pH values were actually yield increases that resulted from extra nitrogen from higher yielding legumes.

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[1] Adams, Fred. 1956. Response of Crops to Lime in Alabama. Auburn University (Ala.) Agr. Exp. Sta. Bull. 301.

A number of liming experiments with corn have been conducted in Alabama during the 1960's, the results of which have not been previously published. Most of these experiments contained no legume in the rotation; they were either continuous corn or corn in rotation with cotton. Nitrogen rates exceeded 100 lb./acre except for two long term rotations that were started in 1930 and whose nitrogen rates have tended to lag behind current recommendations. Yields were disappointing in some experiments, primarily because of drought. Seldom does the crop fail to be affected by drought sometime during its growing season. Adequate rates of nitrogen, phosphorus, potassium and zinc, as well as recommended plant populations and cultural practices, are believed to have been used in these experiments.

Soils were sampled periodically during the experiment and soil pH measured in a 1:1 soil-water mixture by the Auburn University Soil Testing Laboratory. Increases in crop yield caused by liming acid soils is generally thought not to be caused by the change in pH per se but caused by correcting either a deficiency of calcium or magnesium or a toxicity from aluminum or manganese or some combination of these.

"Critical" soil pH is used in this publication to mean that soil pH value which divides "response to lime" from "no response" to liming. It may be different for different soils as well as being different for different crops. A major objective of this publication was to define the "critical" soil pH for corn on several major soil types in Alabama.

The results of 25 different liming experiments with corn at various locations in Alabama during the period 1960 to 1968 are reported. Only grain yields were measured and no inference is drawn for corn used for other purposes such as silage.

RATES OF LIME, 1962-1968

Three experiments with several liming rates were established during 1957-58; one each at the Brewton, Monroeville, and Prattville Experiment Fields. Cotton was grown for the first few years, followed by corn. The experiment consisted of 16 treatments which included 6 lime rates, 2 lime sources, 2 nitrogen rates, and 3 nitrogen sources. Lime rates ranged from none to 8 tons per acre; nitrogen rates were 60 and 240 lb./acre; nitrogen sources were ammonium nitrate, ammonium sulfate, and sodium nitrate.

A wide range in soil pH values had been created by the time corn was planted for the first time in the experiment. The soil pH values and the effects they had on cotton yields during the first phase of this experiment have been published.[2] The experiments at Brewton and Monroeville were changed to corn in 1962 and the one at Prattville in 1967.

No lime has been added to any plot since the original liming treatments were made in 1957 and 1958. The wide range in soil pH values remaining from the earlier lime and nitrogen treatments had created the pH variation needed. The lowest pH was almost 5.0 and the highest was 6.5 to 7.0 at all three locations. All plots were fertilized uniformly for corn.

Norfolk (formerly Kalmia) Sandy Loam
Brewton Experiment Field

The effect of soil pH, ranging from 5.3 to 6.6 in 1962, on corn yield was clear each year, beginning with the first year and continuing through the fifth, Table 1. Yields were not high any year of the experiment; 1965 was the best year with yields near 100 bu./acre while 1966 was the poorest with maximum yields of less than 50 bu./acre. However, the yield response to liming and soil pH was essentially unchanged from year to year. The greatest yearly yield increase to liming ranged from 31 bu./acre in 1965 to 11 bu./acre in 1963. Even in the unusually dry year of 1966, a maximum yield increase of 28 bu./acre for lime was obtained.

The "critical" soil pH appeared to be about pH 5.5, with a definite decrease in grain yield at pH 5.2. There was no "overliming" effect from the higher lime rates. Although corn yields were decreased by low pH, the crop could not be considered a failure even on the most acid soil, the most acid soil producing an average yield of 53 bu./acre.

There was no difference in corn yields between dolomitic and calcitic sources of limestone. This contrasts with the results on this same site with cotton during the previous 5-year period, when seed-cotton yields were about 300 lb./acre greater from dolomitic than from calcitic limestone. Thus, corn was found to be more tolerant of both low soil pH and low soil magnesium than cotton.

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[2] Adams, Fred. 1968. Response of Cotton to Lime in Field Experiments. Auburn Univ. (Ala.) Agr. Exp. Sta. Bull. 376.

TABLE 1. EFFECT OF SOIL PH ON YIELD OF CORN ON NORFOLK (FORMERLY KALMIA) SANDY LOAM, BREWTON EXPERIMENT FIELD, ALABAMA, 1962-1966

Acre rate[1] of lime	Acre yield of corn[5]						Soil pH in February[5]		
	1962	1963	1964	1965	1966	Average	1962	1963	1967
Ton	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*			
0	68	65	70	86	39	66	5.6	5.3	5.4
0	53	55	59	71	25	53	5.3	5.2	5.2
0.5	72	67	73	93	42	69	5.7	5.6	5.5
1.0	69	63	78	90	43	69	5.9	5.7	5.7
1.0	64	62	64	89	41	64	5.5	5.4	5.4
1.0[2]	56	58	59	68	21	52	5.3	5.2	4.9
1.0[3]	62	63	70	96	44	67	6.0	5.8	6.2
1.0[4]	72	63	71	86	43	67	5.8	5.7	5.6
1.0[4]	69	64	69	86	37	65	5.5	5.4	5.3
2.0	75	66	78	98	49	73	5.9	5.8	5.7
2.0	71	64	76	93	45	70	5.6	5.6	5.5
4.0	73	66	75	93	48	71	6.3	6.1	6.2
4.0	76	66	76	96	45	72	6.1	5.9	5.8
4.0[4]	75	65	72	99	49	72	5.9	5.8	5.8
8.0	75	63	74	90	47	70	6.6	6.4	6.6
8.0	71	64	77	91	47	70	6.5	6.4	6.6

[1] Lime was applied in 1957. Cotton was grown each year during 1957-1961. Corn was fertilized annually at per-acre rate of 150 lb. N, 22 lb. P (50 lb. P_2O_5), 42 lb. K (50 lb. K_2O), and zinc; N was ammonium nitrate except treatments with footnotes 2 and 3. Two rates of ammonium nitrate (60 and 240 lb./acre of N) were used at each lime rate, except the 0.5 rate, during the period that cotton was grown.

[2] Nitrogen from ammonium sulfate.

[3] Nitrogen from sodium nitrate.

[4] Calcitic limestone was source of lime. Dolomitic limestone was used on all others.

[5] Average of four replications. Varieties were Dixie 18 and Fla. 200A.

The pH of surface soil (0-7″) changed very little between 1962 and 1967 on plots fertilized with ammonium nitrate but did change some with ammonium sulfate. A total of 750 lb./acre of nitrogen was added during this period. The acidity from this amount of ammonium nitrate is estimated as equivalent to 1,350 pounds of lime; the acidity from ammonium sulfate at the same nitrogen rate is estimated as equivalent to 4,000 pounds of lime. The lack of change in surface-soil pH was somewhat surprising and suggests that acidity either developed in the subsoil or failed to develop at all. However, subsoil acidity was not checked to determine what changes had occurred there.

Magnolia Fine Sandy Loam
Monroeville Experiment Field

When corn was first planted in 1962, soil pH ranged between 5.1 and 6.7 as a result of the previous lime and nitrogen treatments for cotton, Table 2. The soil pH values, as well as the pH range,

TABLE 2. EFFECT OF SOIL pH ON YIELD OF CORN ON MAGNOLIA FINE SANDY LOAM, MONROEVILLE EXPERIMENT FIELD, ALABAMA, 1962-1966

Acre rate[1] of lime	Acre yield of corn[5]						Soil pH in February[5]		
	1962	1963	1964	1965	1966	Average	1962	1963	1967
Ton	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*			
0	75	71	63	39	69	63	5.6	5.5	5.3
0	61	62	64	35	46	54	5.2	5.1	5.1
0.5	78	67	71	40	72	66	5.6	5.5	5.3
1.0	79	63	62	48	78	66	5.7	5.6	5.2
1.0	71	60	64	37	63	59	5.5	5.5	5.1
1.0[2]	55	57	55	22	34	45	5.1	5.1	4.8
1.0[3]	76	68	61	24	50	56	6.1	5.9	6.1
1.0[4]	75	64	64	42	78	65	5.7	5.6	5.3
1.0[4]	68	59	62	32	49	54	5.4	5.3	5.0
2.0	76	60	58	48	76	64	5.8	5.7	5.4
2.0	70	64	68	41	73	63	5.6	5.5	5.2
4.0	86	67	59	38	75	65	6.2	6.1	5.9
4.0	79	63	66	39	70	63	5.9	5.8	5.5
4.0[4]	81	68	64	38	78	66	6.0	5.8	5.5
8.0	80	63	63	60	76	68	6.7	6.5	6.5
8.0	85	63	66	45	74	67	6.3	6.2	6.3

[1] See footnote 1 in Table 1.
[2] Nitrogen from ammonium sulfate.
[3] Nitrogen from sodium nitrate.
[4] Calcitic limestone was source of lime. Dolomitic limestone was used on all others.
[5] Average of three replications. Varieties were Dixie 18 and Florida 200A.

were remarkably similar to those for the same treatments on Norfolk soil at the Brewton Experiment Field.

None of the five years was especially favorable for corn yields. The best year was 1962 with a high yield of 86 bu./acre; the worst year was 1965, when most yields were less than 50 bu./acre. However, yield differences caused by different pH values were essentially the same from year to year. For example, the greatest yearly yield increase for liming ranged from 31 bu./acre in the best year (1962) to 38 bu./acre in the poorest year (1965).

The relationship between soil pH and grain yield of corn at the Monroeville Experiment Field was remarkably similar to that at the Brewton Experiment Field. "Critical" soil pH was about pH 5.5 on both soils; yields were definitely less at pH 5.2. The most acid plots (pH 4.8) of the Magnolia soil produced an average of 44 bu./acre, 25 bushels less than the best yield.

There was no difference in corn yields between dolomitic and calcitic sources of limestone. These same plots during the previous 5-year period had shown a slight yield increase in cotton in favor of dolomitic limestone. As on the Norfolk soil at Brewton, corn proved to be more tolerant of both low soil pH and low soil magnesium than cotton had been on the same plots.

There was generally a greater decrease in pH of the Magnolia surface soil than the Norfolk surface soil at Brewton. Because internal drainage is slower in the finer-textured Magnolia soil, there was probably less leaching in this soil and more accumulation of acidity within the surface layer of soil than was the case with the coarser-textured Norfolk soil.

Lucedale (formerly Greenville) Sandy Clay Loam Prattville Experiment Field

The liming rates for this experiment were applied in 1958, and cotton was planted for the next nine years. When corn was first planted on the experimental site in 1967, soil pH ranged from a low of 4.9 to a high of 6.9 with numerous intermediate values, Table 3.

TABLE 3. EFFECT OF SOIL PH ON YIELD OF CORN ON LUCEDALE (FORMERLY GREENVILLE) SANDY CLAY LOAM, PRATTVILLE EXPERIMENT FIELD, ALABAMA, 1967-1968

Acre rate[1] of lime	Acre yield of corn[5] 1967	1968	Average	Soil pH[5] in February, 1967
Ton	*Bu.*	*Bu.*	*Bu.*	
0	122	66	94	5.8
0	119	60	90	5.2
0.5	124	63	94	5.9
1.0	124	67	96	6.0
1.0	127	59	93	5.4
1.0[2]	109	50	80	4.9
1.0[3]	137	64	101	6.3
1.0[4]	132	65	99	6.0
1.0[4]	142	64	103	5.6
2.0	125	70	98	6.1
2.0	132	66	99	5.5
4.0	130	68	99	6.6
4.0	146	69	108	5.9
4.0[4]	136	71	104	5.8
8.0	129	68	99	6.9
8.0	136	70	103	6.4

[1] Lime was applied in 1958. Cotton was grown each year during 1958-1966. Corn was fertilized annually with 275 lb./acre of 4-12-12 plus zinc and 325 lb./acre of ammonium nitrate. Two rates of ammonium nitrate (60 and 240 lb./acre of N) were used at each dolomitic lime rate during the period that cotton was grown, except the 0.5 rate.

[2] Cotton was fertilized with ammonium sulfate during 1958-1966.

[3] Cotton was fertilized with sodium nitrate during 1958-1966.

[4] Calcitic limestone was source of lime. Dolomitic limestone was used on all others.

[5] Average of 4 replications. Variety was Pioneer 309B.

Corn yields in 1967 were unusually high for the Prattville Experiment Field, ranging from a low of 109 bu./acre on the most acid soil (pH 4.9) to a high of 146 bu./acre on limed soil, a yield difference of 37 bu./acre. Yields in 1968 were about half those in 1967 as a result of an unfavorable rainfall distribution. Nevertheless, the most acid soil in 1968 produced 21 fewer bushels per acre than did the highest yielding limed soil.

The data suggests that the "critical" pH of this soil was quite low, yields being about equal at all soil pH levels except for the most acid soil (pH 4.9). As with cotton in the earlier phase of this experiment, pH of the Lucedale soil had to be lower than it did for Norfolk and Magnolia soil to cause a reduction in corn yields.

Corn yields were no higher on soil limed with dolomitic limestone than they were on soil limed with calcitic limestone. Neither did cotton show an advantage for dolomite during the previous 9-year period. Therefore, this soil contained adequate available magnesium for these crops during this cropping period.

Marlboro Fine Sandy Loam
Gulf Coast Substation, Fairhope

A fourth experiment with several liming rates was established in 1966 with continuous corn on an area of Marlboro fine sandy

TABLE 4. EFFECT OF LIME AND NITROGEN RATES ON YIELD OF CORN AND SOIL PH ON MARLBORO FINE SANDY LOAM, GULF COAST SUBSTATION, FAIRHOPE, ALABAMA, 1966-1968[1]

Acre rate of lime	Acre rate of N	Acre yield of corn[3]				Soil pH in February, 1968[3]
		1966	1967	1968	Average	
Ton	*Lb.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	
0	120	54	58	58	57	4.8
0	240	55	51	41	49	4.7
1.0	120	64	76	60	67	5.1
1.0[2]	120	62	66	55	61	5.4
1.0	240	65	72	53	63	5.1
2.0	120	69	76	61	69	5.5
2.0	240	64	74	58	65	5.5
4.0	120	71	72	60	68	6.1
4.0[2]	120	64	71	59	65	6.2
8.0	120	71	73	57	67	6.6
12.0	120	68	66	57	64	6.7
12.0[2]	120	62	72	62	65	6.9

[1] All plots fertilized annually with 400 lb./acre of 4-12-12 plus zinc and side-dressed with ammonium nitrate.

[2] Calcitic limestone was source of lime; dolomitic limestone was used on all others.

[3] Average of four replications. Variety was Coker 71.

loam that had been in cultivation for many years but had probably never been limed. Six liming rates, 2 lime sources, and 2 nitrogen rates constituted the treatments. Yields were disappointing for this area of Alabama, the highest yield being 76 bu./acre during the period of 1966-68, Table 4.

Soil pH values in 1968 ranged between 4.7 and 6.9. Corn yields were unaffected over the pH range between 5.1 and 6.9. It was only at pH 4.8 and 4.7 that yields were reduced, the average reduction being between 10 and 20 bu./acre. No "overliming" was evident, even at the 12-ton/acre lime rate.

The Marlboro soil contained adequate magnesium for corn because calcitic and dolomitic limestone produced equal yields.

MAGNESIUM-LIME EXPERIMENT, 1960-1968

An experiment to determine lime and magnesium requirements of corn and cotton was established in 1960 on 2 separate locations. It was a 2-year rotation of corn and cotton with each crop being planted every year on alternate, but adjacent, areas. The experiment consisted of 4 magnesium levels at each of 2 soil-pH levels.

One experiment was on Norfolk (formerly Kalmia) sandy loam at the Brewton Experiment Field and the other experiment was on Hartsells fine sandy loam at the Sand Mountain Substation, Crossville, Alabama. Soil pH on the limed plots was maintained near 6.0 with calcitic limestone throughout the test-period.

Liming Norfolk sandy loam at pH 5.6 increased average corn yields by 5 bu./acre; liming Hartsells fine sandy loam at pH 5.2 increased yield by 7 bu./acre, Table 5. Although both yield increases were small, they were consistent from year to year.

TABLE 5. EFFECT OF LIME ON YIELD OF CORN IN A MAGNESIUM EXPERIMENT ON A 2-YEAR ROTATION OF CORN AND COTTON AT BREWTON EXPERIMENT FIELD, ALABAMA, AND SAND MOUNTAIN SUBSTATION, CROSSVILLE, ALABAMA[1]

Location	Soil type	Years	Variety	Acre yield of corn[2]		pH of unlimed soil	
				Unlimed	Limed	1960	1967
				Bu.	*Bu.*		
Brewton	Norfolk sandy loam	1960-68	Dixie 18 & Fla 200A	64	69	5.7	5.5
Crossville	Hartsells fine sandy loam	1960-66	Pioneer 309A	84	91	5.3	5.2

[1] Fertilized annually at rate of 100-60-60.
[2] Average of four treatments, each with 4 replications.

Magnesium had no effect on corn yields at either location. However, cotton yields were increased by magnesium additions on the same plots in the rotation at both locations.

NITROGEN-PHOSPHORUS-POTASSIUM EXPERIMENT, 1962-1964

A fertilizer-rate experiment that included a lime variable was established at several locations in 1954. Cotton was planted from 1954 through 1961; corn was planted from 1962 through 1964. An agricultural-grade dolomitic limestone was added during this period at rates and frequencies designed to maintain soil pH near 6.0.

The biggest yield increase for liming was 19 bu./acre at Headland, Alabama, on Dothan sandy loam (formerly Norfolk) at pH 5.5, Table 6. No yield increase resulted from liming Lucedale sandy loam (at Prattville) at pH 5.6, Savannah very fine sandy loam (at Winfield) at pH 5.2 or Decatur clay loam (at Belle Mina) at pH 5.6.

TABLE 6. EFFECT OF LIME ON YIELD OF CORN IN A N-P-K EXPERIMENT WITH CONTINUOUS CORN (FOLLOWING 8 YEARS OF CONTINUOUS COTTON) AT SEVEN LOCATIONS IN ALABAMA, 1962-1964[1]

Location	Soil type	Variety	Per acre yield[2]		pH of unlimed soil in 1962
			Unlimed	Limed	
			Bu.	*Bu.*	
Brewton Exp. Field	Norfolk[3] sandy loam	Dixie 18	67	70	5.5
Monroeville Exp. Field	Magnolia fine sandy loam	Dixie 18	47	47	5.4
Wiregrass Sub., Headland	Dothan[4] sandy loam	Fla. 200	67	86	5.5
Prattville Exp. Field	Lucedale[5] sandy loam	Pioneer 309B, Funk's G-730	38	38	5.6
Upper C.P. Sub., Winfield	Savannah very fine sandy loam	DeKalb 805	80	82	5.2
Sand Mt. Sub., Crossville	Hartsells fine sandy loam	Pioneer 309A	107	114	5.2
Tenn. Valley Sub., Belle Mina	Decatur clay loam	P.A.G. 434	65	64	5.6

[1] Fertilized annually at per-acre rate of 120-100-100.
[2] Average of 4 replications.
[3] Formerly Kalmia soil.
[4] Formerly Norfolk soil.
[5] Formerly Greenville soil.

The highest average yield was 114 bu./acre at Crossville; the lowest was 38 bu./acre at Prattville. Yields were also very low at Monroeville.

TWO YEAR ROTATION OF CORN-COTTON-VETCH, 1960-1967

A 2-year rotation of corn-cotton-vetch with several soil fertility variables was established in 1929 and 1930 at different locations throughout Alabama. The experiment had been discontinued at a few locations by 1960 and was discontinued at the remaining seven sites by 1968.

Corn was planted each year on one-half the plots and cotton was planted on the remaining half. One of the better-fertilized treatments remained unlimed throughout the period, while a comparably fertilized treatment was limed periodically to maintain a soil pH near 6.0. Fertilizer rates were increased from time to time

TABLE 7. EFFECT OF LIME ON YIELD OF CORN IN A TWO-YEAR ROTATION OF CORN-COTTON-VETCH AT EIGHT LOCATIONS IN ALABAMA, 1960-1967[1]

Location	Soil type	Variety	Acre yield[2]		pH of unlimed soil in 1963
			Unlimed	Limed	
			Bu.	*Bu.*	
Main Station, Auburn[3]	Lakeland loamy sand	Fla. 200A	65	86	5.1
Brewton Exp. Field	Norfolk[4] sandy loam	Dixie 18 & Fla. 200A	66	76	5.3
Monroeville Exp. Field	Magnolia fine sandy loam	Dixie 18 & Fla. 200A	62	72	5.0
Wiregrass Sub., Headland	Dothan[5] sandy loam	Fla. 200, 200A	60	71	4.9
Prattville Exp. Field	Lucedale[6] sandy clay loam	Pioneer 309B	77	78	4.9
Sand Mt. Sub., Crossville	Hartsells fine sandy loam	Funk's G-704 & Pioneer 309A	82	94	5.2
Alexandria Exp. Field	Decatur clay loam	P.A.G. 633 & Funk's 4703	82	80	5.6
Tenn. Valley Sub., Belle Mina	Decatur clay loam	P.A.G. 434	63	60	5.1

[1] Annual fertilizer rate = 60-60-60.

[2] Average of duplicates.

[3] Three-year rotation of cotton-vetch-corn-oats-soybeans. Corn fertilized with 120 lb./acre of N annually.

[4] Formerly Kalmia soil.

[5] Formerly Norfolk soil.

[6] Formerly Greenville soil.

during the experiment to keep them current with recommended practices. The last fertilizer adjustment was made in 1960, when the fertilizer nitrogen rate for corn was changed to 60 lb./acre. Legumes in the rotation supplied an unknown amount of nitrogen to the corn. Only yields obtained since 1960 are reported.

Corn yields were increased by liming at 5 of the 8 locations, Table 7. No response to lime was obtained on Lucedale sandy clay loam (at Prattville) at pH 4.9, on Decatur clay loam (at Alexandria) at pH 5.6, and on Decatur clay loam (at Belle Mina) at pH 5.1. The highest average yield-increase from liming was 21 bu./acre on Lakeland loamy sand (at Auburn) at pH 5.1.

Since nitrogen was added to corn at only 60 lb./acre, except for the experiment at Auburn, there may have been some yield response to the extra nitrogen supplied by higher vetch yields on the limed plots. However, since the yield increases for lime in this experiment are similar to increases in other experiments at similar pH levels, but containing no legume, these yield increases appear to be caused by differences in soil pH and not by differences in nitrogen rate.

SOURCE OF NITROGEN EXPERIMENT, 1960-1967

An experiment was established in 1929 and 1930 at several locations in Alabama to determine if lime affected the relative merits of different nitrogen fertilizers in a 2-year rotation of corn and cotton. Corn and cotton were both planted every year, each on alternate halves of the test-area. The experiments had been discontinued at all but four locations by 1960 and has since been discontinued at two more. Treatments reported here have been altered since establishment only by increasing annual fertilizer rates periodically to keep them current with recommendations. The last change was made in 1960 when nitrogen rate was increased to 72 lb./acre and only yields since 1960 are reported.

The continuous use of equal nitrogen rates from ammonium sulfate, ammonium sulfate plus lime, and sodium nitrate resulted in widely different soil pH levels by 1960, Table 8. The largest yield-reduction from low pH was on the Hartsells fine sandy loam (at Crossville) at pH 4.5, where an average of only 19 bu./acre was harvested during the 8-year period. This was the lowest pH, and the lowest yield, reached on any soil. Dothan sandy loam (formerly Norfolk) at pH 5.2 (at Headland) averaged about half

TABLE 8. EFFECT OF SOIL pH ON YIELD OF CORN IN A NITROGEN-SOURCE EXPERIMENT IN A TWO-YEAR ROTATION OF CORN AND COTTON AT FOUR LOCATIONS IN ALABAMA, 1960-1967[1]

Location	Soil type	Years	Variety	Ammonium sulfate		Amm. sulfate & lime		Sodium nitrate	
				Acre yield	Soil pH in 1960	Acre yield	Soil pH in 1960	Acre yield	Soil pH in 1960
				Bu.		*Bu.*		*Bu.*	
Monroeville Exp. Field	Magnolia fine sandy loam	1960-62	Dixie 18	52	4.8	62	5.6	65	5.7
Wiregrass Sub., Headland	Dothan[2] sandy loam	1960-61	Dixie 18	32	5.2	59	6.0	61	5.9
Sand Mt. Sub., Crossville	Hartsells fine sandy loam	1960-67	Funk's G-704 Pioneer 309A	19	4.5	72	5.5	75	6.1
Tenn. Valley Sub., Belle Mina	Decatur clay loam	1960-67	P.A.G. 434	54	5.1	57	5.7	58	5.9

[1] Annual fertilizer rate to corn = 72-60-60 plus zinc. Average of 2 replications.
[2] Formerly Norfolk sandy loam.

the yield as that at pH 6.0. Yields were also reduced sharply on Magnolia fine sandy loam (at Monroeville) at pH 4.8. Contrary to the detrimental effect of low pH on yields at Crossville, Headland, and Monroeville, Decatur clay loam (at Belle Mina) made about as much corn on plots at pH 5.1 as on plots at pH 5.9.

RESPONSE BY PHYSIOGRAPHIC REGION

The most important, single soil pH value for liming purposes is the pH that divides "no response" from "yield response." This pH is frequently called the "critical" pH. The data presented in this publication clearly show that "critical" pH was not the same for all soils but varied from about pH 5.0 to at least 5.5.

Rigid conclusions relating corn yields to specific and well-defined soil pH values should be avoided because experience has shown that pH of different samples of the same soil is not a property that can be measured with great precision. Soil pH changes from place to place within the soil, it changes from season to season and from year to year. The reasons for these changes are not clearly understood. In an earlier report on liming experiments with cotton in Alabama[3], it was pointed out that soil pH sometimes varied as much as 0.5 pH from year to year, even when sampling was done in the same manner and at the same time each year in an effort to minimize pH variations. However, if due allowance is made for seasonal variation in soil pH, the "critical" pH for a particular crop on a particular soil can probably be determined within a 0.2 to 0.3 pH unit.

It is not possible to identify a "critical" pH from a 2-rate lime experiment; several liming rates are necessary. Therefore, only experiments with several liming rates are used in this report to define "critical" soil pH for corn. A cursory examination of the data in the various tables shows that "critical" pH varied considerably among the soils. In an effort to better define "critical" pH, soils are grouped according to physiographic region in the discussion that follows.

Coastal Plains Soils

Results of 17 different liming experiments with corn on Coastal Plains soils are reported here, four of which were suitable for determining "critical" soil pH values for corn.

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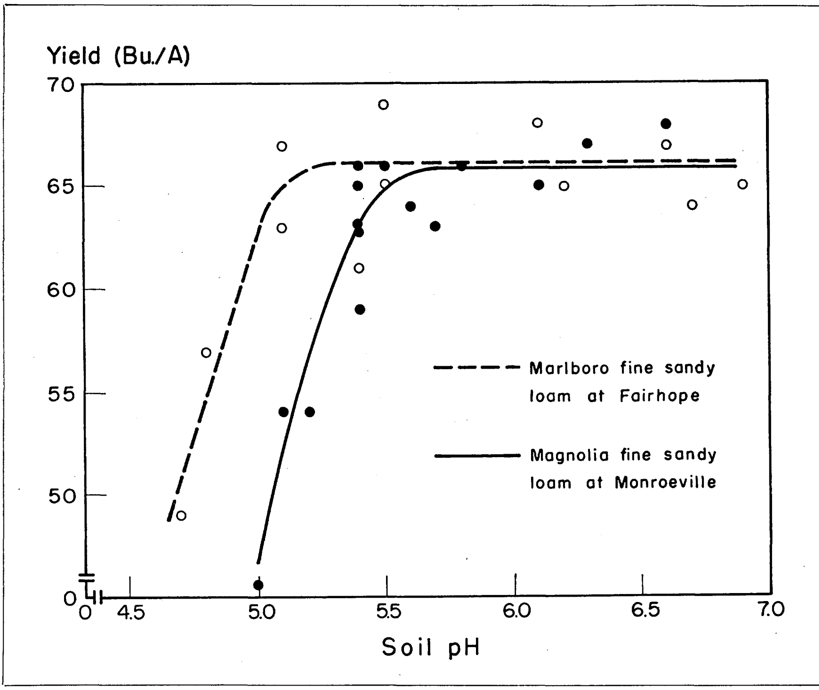
[3] Adams, Fred. 1968. Response of Cotton to Lime in Field Experiments, Auburn University (Ala.) Agr. Exp. Sta. Bull. 376.



Effect of soil pH on yield of corn on two similar soil types with different "critical" pH values is shown.

Inspection of the data in Tables 1-4 shows that "critical" soil pH is higher on Norfolk (at Brewton) and Magnolia (at Monroeville) soils than on Lucedale (at Prattville) and Marlboro (at Fairhope) soils. This observation can be better seen by the data in the Figure, where corn yields of the lime-rate experiments are graphed against soil pH on Magnolia fine sandy loam and Marlboro fine sandy loam. Separate lines are drawn to fit the yield-pH points for each experiment. Changes in the slopes of these lines suggest a "critical" pH for corn of about 5.5 for the Magnolia soil and of about 5.0 for the Marlboro soil.

Yield data and soil pH values listed in the different tables suggest that soils of the Coastal Plains reported here fall into two groups relative to "critical" pH for corn. The Dothan, Lakeland, Magnolia, and Norfolk soils appear to have a "critical" soil pH of about 5.5 and the Lucedale (formerly Greenville), Marlboro, and Savannah soils have a "critical" pH of only about 5.0.

Appalachian Plateau (Sand Mountain)

Results of four experiments on Hartsells fine sandy loam at the Sand Mountain Substation, Crossville, are reported in Tables 5-8. Average pH of each unlimed soil in three of the experiments was 5.2; therefore, there was an inadequate range in soil pH values to identify clearly the "critical" pH. However, a reasonable estimate of the "critical" pH can be made because average per-acre yields were increased between 7 and 12 bu. by liming at pH 5.2. This was a 10 to 15 per cent yield increase at a yield level of about 100 bu./acre. Thus, "critical" pH for corn on this soil appears to be between 5.2 and 5.4

Limestone Valleys

Results of four experiments on limestone valley soils are reported in Tables 6-8 (3 at Belle Mina and 1 at Alexandria), none of which showed corn yields to be increased by liming. Average pH of the unlimed soil was 5.6 in two experiments and 5.1 in the other two. With these few data available, no firm conclusion about "critical" pH for corn can be reached for these soils. From general knowledge about soil acidity and crop response, however, a reasonable estimate of "critical" pH would be about 5.0.

SUMMARY AND CONCLUSIONS

Results of 25 different field experiments, all conducted since 1960, on liming soils for corn in Alabama are reported. The experimental sites were located throughout the State and represent some of the major soil types of the area. Average corn yields ranged generally between 70 and 100 bu./acre, with yields for individual years varying between 30 and 150 bu./acre because of variations in drought severity. All of the experiments were on unirrigated lands and all were adequately fertilized with nitrogen, phosphorus, potassium, and zinc.

The term "critical" pH is used extensively in this publication. It is used here to mean the soil pH value that divides "no response" from "yield response" to liming. In order to minimize variation in soil pH caused by seasonal variations, soils were generally sampled in February. Since effects from residual fertilizers on soil pH is at a minimum at that time of the year, soil pH is about maximum. Sampling the soil during summer or fall would have resulted in lower "critical" pH values, as defined here, because of the greater influence of residual fertilizer on measured pH values.

The following conclusions are drawn from these experiments:

1. If soil pH was above the "critical" value, corn yields were unaffected by liming over a wide soil pH range (adequate fertilizer, including zinc, was added).

2. "Critical" soil pH values for corn varied for different soils. The highest "critical" pH (about 5.5) was found for Dothan (formerly Norfolk) sandy loam at Headland, Lakeland loamy sand at Auburn, Magnolia fine sandy loam at Monroeville, and Norfolk (formerly Kalmia) sandy loam at Brewton. The lowest "critical" pH (about 5.0) was found for Decatur clay loam at Belle Mina, Lucedale (formerly Greenville) sandy clay loam at Prattville, and Marlboro fine sandy loam at Fairhope. The "critical" pH for Hartsells fine sandy loam at Crossville on Sand Mountain was intermediate.

3. Magnesium deficiency was not evident on any soil where calcitic limestone was compared to dolomitic limestone as a liming material.

4. Since present knowledge is not adequate to permit ready identification of soils with different "critical" pH values for liming, a soil should be limed for corn if its pH is below 5.8 in order to keep soil pH well above the "critical" value and to allow for periods of intense acidification, such as that which follows applications of high rates of ammonia nitrogen.

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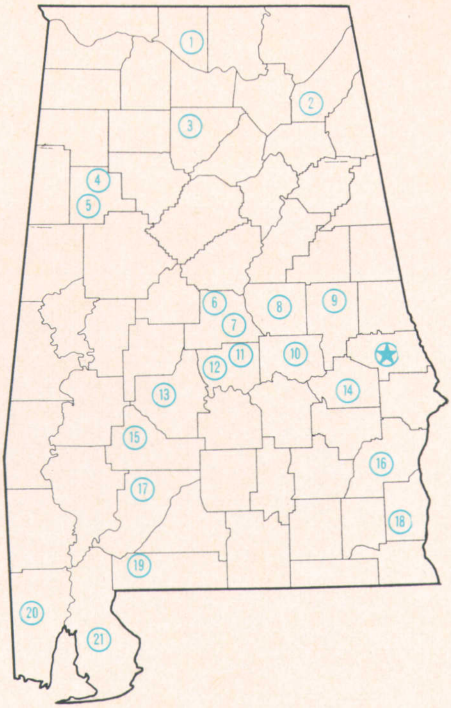
AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.