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COASTAL BERMUDAGRASS RESPONSE TO LIMESTONE AND PHOSPHORUS

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SUMMARY

Coastal bermudagrass yield and leaf mineral response to applied limestone and concentrated triple superphosphate were evaluated on an acid, sandy soil over three years. Soil pH increased from 4.7 to 6.2 two years after 1.7 tons lime/acre was applied. Four years after liming, soil pH at this lime rate declined to 4.6 due to the acidity produced from N fertilization. Yield increased by as much as 37% from P application, but was unaffected by lime. Soil test P levels declined over the three years from P losses due to plant uptake and chemical fixation. This caused maximum yield response to increase from 123 (1983) to 982 (1986) lb P_2O_5/ac. Nevertheless, yield increases plateaued at 10 to 15 ppm soil test P in all years. Phosphorus fertilization also increased leaf P, Ca, and Mg concentrations. Although liming did not improve yield, this practice would be recommended to increase forage Ca and Mg concentrations and to maintain the suitability of the land for growing less acid-tolerant forage crops.

INTRODUCTION

East Texas soils are becoming increasingly acidic. A summary of test results evaluated in the late 1960's revealed that 2% of these soils tested below pH 5.2. A similar evaluation in the early 1980's indicated that 12% tested below pH 5.0. As soil pH declines, plant susceptibility to acid soil infertility and inadequate plant P increases. The objectives of this study were to evaluate the effects of limestone and phosphorus application on Coastal bermudagrass yield and leaf mineral concentration in a strongly acid, Lilbert soil.

PROCEDURES

This study was initiated in July, 1983 on a Lilbert loamy fine sand having an initial surface 6-inch depth soil pH of 4.7. Agricultural grade limestone (100% minus 8-mesh and 27% minus 100-mesh) treatments of 0, 0.3, and 1.7 tons/ac were applied as main plots to an established Coastal bermudagrass meadow. Concentrated triple superphosphate was applied two separate times to split plots at rates of 0, 30, 61, 92, 123, 245, and 491 lb P_2O_5/ac. All treatments were replicated 8 times in a randomized complete block arrangement. The lime and first

P applications were roto-till incorporated into the soil in July 1983. The second P application was lightly disked into the soil in June 1984. Six-inch depth soil samples were taken in November 1983, July 1985, and June 1987. Soil samples were analyzed according to Texas A&M University soil testing laboratory procedures. Nitrogen was uniformly broadcast on the plots prior to initiation of spring growth and following each harvest. Over the study period, a total of 1200 lb N/ac and 950 lb K_2O/ac were applied to the plots. Environmental conditions were sufficiently varied to affect forage growth from year to year. The plots were clipped twice in 1983 and three times in 1985 and 1986. Dry matter yields were calculated based on oven dried (140° F) weights. Chemical analysis of leaf tissue was determined after digesting dried, minus 40-mesh moisture determination samples in $LiSO_4$-$CuSO_4$-Se-H_2SO_4.

RESULTS

The high limestone rate (1.7 tons/ac) increased soil pH from 4.7 to 5.7 by November, 1983 and to 6.2 in 1985 (Table 1). By 1987, soil pH in these plots had declined to the unlimed soil levels due to the acidity generated by N fertilization. Limestone also increased soil test P, Ca, and Mg, and decreased soil K and Al. As indicated by 1987 soil test data, limestone's effect on soil nutrients lingered beyond its ability to increase soil pH. In all years, P application increased soil test P and decreased soil K (Table 2). Soil P and Mg were at their highest and soil Al was at its lowest in 1985. By 1987, soil P, Ca, and Mg decreased due to their plant uptake, losses from leaching, or reversion into more chemically stable forms. Also, by 1987 soil Al increased in the high lime plots as soil pH decreased.

Coastal bermudagrass dry matter yield increased by almost one ton per acre each year due to P application, but did not respond to liming (Table 3). These data indicated that Coastal bermudagrass productivity was unaffected by potentially phytotoxic levels of Al and deficient soil Ca and Mg. The effect of P rate on yield was different in each year because soil P availability declined over the study due to plant uptake and reversion of soil P into nonavailable forms. Coastal bermudagrass yield was consistently highest when soil test P was 10 to 15 ppm (Fig. 1). Rather than recommending specific fertilizer P rates, applying fertilizer P based on soil test P data appeared to offer the most efficient means of achieving the highest yields.

Lime applied in 1983 increased leaf Ca and Mg in all years and decreased leaf P and K concentrations in 1983 and 1986, respectively (Table 4). Although soil

testing indicated liming increased soil P availability, this was not reflected in higher leaf P concentrations at the 1.7 ton lime/ac rate. Applied P increased tissue P and Mg in all years, increased leaf Ca in 1985 and 1986, and decreased leaf K concentration in 1986. Critical leaf P concentration was 2.2 in 1985 and 1.6 ppm P in 1983 and 1986 (Fig. 2).

TABLE 1. SOIL TEST PARAMETERS AS AFFECTED BY APPLIED LIMESTONE IN 1983, 1985 AND 1987

Limestone Rate (tons/ac)	Soil Test Parameter					
	pH	P	K	Ca	Mg	Al
		ppm				
			1983			
0	4.72	14.6	82	109	6.4	23.4
0.3	4.80	14.6	81	201	9.0	19.6
1.7	5.66	17.7	70	762	18.7	8.9
			1985			
0	4.51	14.1	117	143	10.2	17.2
0.3	4.65	13.9	117	184	11.4	11.4
1.7	6.19	18.7	111	580	21.9	0.3
			1987			
0	4.50	9.0	72	162	†	23.9
0.3	4.49	9.7	73	169		23.4
1.7	4.61	7.6	59	296		13.1

† Soil test Mg not applicable in 1987.

TABLE 2. SOIL TEST PARAMETERS AS AFFECTED BY APPLIED P IN 1983, 1985 AND 1987

P_2O_5 Rate (lb/ac)	Soil Test Parameter					
	pH	P	K	Ca	Mg	Al
		ppm				
			1983			
0	5.12	7.9	90	367	11.9	16.6
30	5.11	9.9	84	442	12.3	17.2
61	5.10	10.0	84	315	11.2	18.1
92	5.05	12.0	78	368	10.9	16.5
123	5.04	13.8	74	290	10.4	15.8
245	5.02	16.6	70	364	11.0	19.8
491	4.97	39.3	62	356	11.9	16.8
			1985			
0	5.11	3.4	129	263	14.2	9.7
61	5.18	4.7	121	314	15.1	9.5
123	5.12	7.6	116	277	13.9	9.8
184	5.10	11.5	113	303	14.3	10.5
245	5.13	13.8	109	304	15.7	9.5
491	5.11	23.6	109	335	14.0	9.3
982	5.07	44.4	107	320	14.4	9.1
			1987			
0	4.52	3.6	75	197	†	20.6
61	4.54	3.9	73	195		19.6
123	4.57	5.3	72	199		19.4
184	4.56	5.8	67	214		19.7
245	4.53	7.5	64	196		19.6
491	4.57	12.5	64	243		19.7
982	4.44	23.1	61	216		22.3

† Soil test Mg not application in 1987.

TABLE 3. COASTAL BERMUDAGRASS DRY MATTER YIELD AS AFFECTED BY APPLIED P IN 1983, 1985 AND 1987

P_2O_5 Rate (lb/ac)	Year		
	1983	1985	1986
	lb/ac		
0†	5550	10000	8660
61	6080	10540	9110
123	6250	11340	9460
184	7060	12410	9550
245	7600	12140	9550
491	7070	11520	9910
982	7610	11960	10270

† P_2O_5 rates in 1983 were half the indicated rate.

TABLE 4. MEAN COASTAL BERMUDAGRASS TISSUE MINERAL CONCENTRATIONS AS AFFECTED BY APPLIED LIMESTONE IN 1983, 1985 AND 1987

Limestone Rate (tons/ac)	Tissue Mineral Parameter			
	P†	K	Ca	Mg
	%			
	1983			
0	0.180	1.68	0.260	0.102
0.3	0.180	1.65	0.264	0.105
1.7	0.169	1.62	0.308	0.114
	1985			
0	0.237	2.19	0.239	0.137
0.3	0.236	2.17	0.267	0.144
1.7	0.240	2.16	0.358	0.161
	1986			
0	0.172	1.64	0.241	0.107
0.3	0.176	1.60	0.265	0.114
1.7	0.168	1.42	0.374	0.145

† Plant parameters represent mean values from 2, 3, and 3 clippings in 1983, 1985, and 1986, respectively.

TABLE 5. MEAN COASTAL BERMUDAGRASS TISSUE MINERAL CONCENTRATIONS AS AFFECTED BY APPLIED P IN 1983, 1985 AND 1987

P_2O_5 Rate (lb/ac)	Tissue Mineral Parameter			
	P†	K	Ca	Mg
	%			
		1983		
0	0.147	1.63	0.276	0.100
30	0.153	1.63	0.282	0.107
61	0.164	1.59	0.271	0.104
92	0.172	1.62	0.272	0.108
123	0.182	1.74	0.276	0.108
245	0.186	1.62	0.278	0.109
491	0.229	1.72	0.286	0.114
		1985		
0	0.193	2.20	0.271	0.140
61	0.212	2.17	0.278	0.143
123	0.224	2.23	0.287	0.144
184	0.243	2.20	0.296	0.151
245	0.245	2.15	0.294	0.150
491	0.261	2.16	0.287	0.149
982	0.287	2.12	0.303	0.153
		1986		
0	0.157	1.64	0.280	0.114
61	0.157	1.61	0.274	0.114
123	0.165	1.61	0.290	0.118
184	0.171	1.54	0.291	0.120
245	0.168	1.51	0.294	0.124
491	0.184	1.51	0.301	0.128
982	0.202	1.44	0.323	0.133

† Plant parameters represent mean values from 2, 3, and 3 clippings in 1983, 1985, and 1986, respectively.

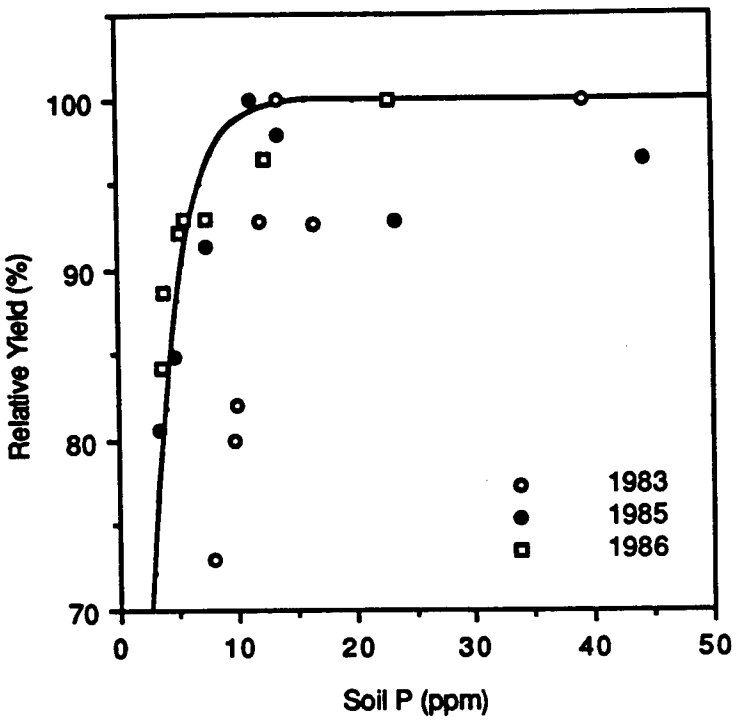

Figure 1. The relationship between relative Coastal bermudagrass yield and soil test P in 1983, 1985, and 1986.

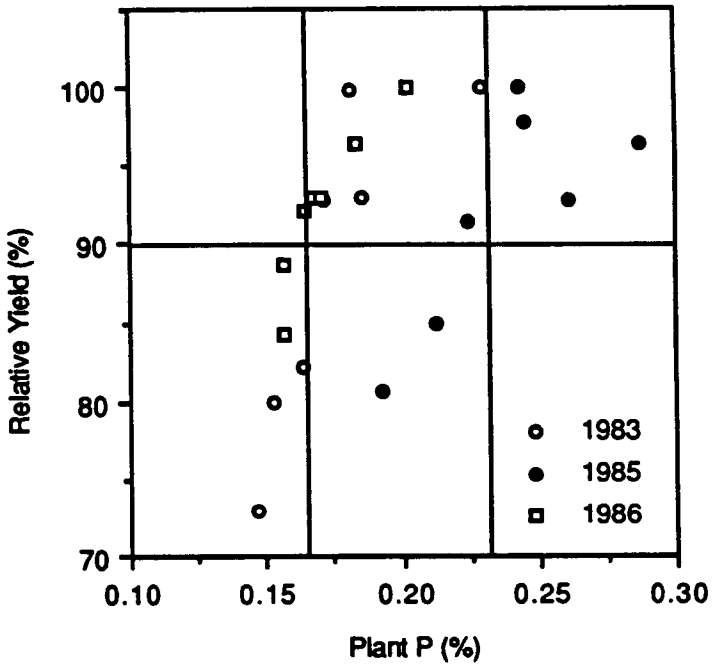

Figure 2. Scatter diagram of relative Coastal bermudagrass yield versus mean tissue P concentration in 1983, 1985, and 1986.