Corn Response to Phosphorus and Potassium Fertilization at Different Soil-Test Levels

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RESEARCH PROBLEM

Modern corn (*Zea mays* L.) hybrids, more intensive management systems, and crop rotations not previously used may result in different phosphorus (P) and potassium (K) fertilizer requirements than those traditionally recommended. Studies on nitrogen (N) requirements for corn in Arkansas in the 1980s identified a need to modify N recommendations for modern hybrids on fine-textured soils (Muir et al., 1992). The studies described in this manuscript were initiated in 1997 to evaluate the response of corn grain yield to P and K fertilization on a range of soil test P and K values.

BACKGROUND INFORMATION

Current P and K fertilizer recommendations for corn are based on research conducted several years ago and may not be adequate for corn grown in current production systems. Calibration studies are continuously needed to confirm the validity of current P and K recommendations or to provide unbiased evidence to justify modification of these recommendations.

RESEARCH DESCRIPTION

In 1997, P and K calibration studies were initiated on a Calloway silt loam soil at Arkansas State University (ASU) located in Jonesboro. A site with a range of P and K soil-test values was located in order to impose fertilizer rate treatments on blocks that varied in initial Mehlich 3-extractable P and K. The site had a range of soil-test K, but had a limited range of soil-test P. Soil-test K ranged from 85 to 272 lb K/acre (Mehlich 3, 1:7 extraction ratio) and soil-test P ranged from 17 to 50 lb P/acre (Mehlich 3, 1:7 extraction ratio). Phosphorus and K fertilizer rates of 0, 0.5, 1.0, and 2.0 times the recommended rates (1× rates were 70 lb P_2O_5/acre and 90 lb K_2O/acre) for the lowest soil test P and K values were broadcast and incorporated before planting each year.

The ASU location was lost after the 2001 season. A new trial was initiated at the Pine Tree Branch Station in 2002 on a Calhoun silt loam soil. Soil test P and K values (Mehlich 3, 1:7 extraction ratio) averaged 44 lb P/acre and 204 lb K/acre, respectively. Treatments included in the trial were 0, 80, 120, and 160 lb P_2O_5/acre as triple super phosphate and 0, 70, 105, and 140 lb K_2O/acre as muriate of potash (KCl). Phosphorus and K treatments were applied to the 2002 trial on 29 March and the hybrid Pioneer 3223 was planted on 10 April. Urea was applied preplant at a rate of 120 lb N/acre to the entire experimental area on 9 April. An additional sidedress application of 213 lb N/acre as 32% urea ammonium nitrate was applied to the entire experimental area on 29 May. The experimental design was a randomized complete block design with four replications.

RESULTS

Phosphorus fertilization had no significant influence on corn grain yield at the PTBS during 2002 (Table 1). However, yields in 2002 were relatively low suggesting another factor may have been more limiting than P. Previous trials conducted at the ASU site (Tables 2 and 3) showed significant yield responses to P fertilization on soils with initial Mehlich 3-extractable P ranging from 20 to 30 lb P/acre in 3 of 5 years. At the ASU site, Mehlich 3-extractable soil P in topsoil samples taken after corn harvest increased as P fertilizer rate increased (Tables 2 and 3). Linear regression showed that each year soil-test P increased between 0.06 to 0.29 lb P/acre per 1 lb P_2O_5 fertilizer applied. The rate of soil-test P increase

was much lower (0.06 to 0.07 lb/acre per 1 lb P_2O_5 fertilizer) in 1998 compared to post-harvest samples taken in 1997, 1999, and 2000 (0.23 to 0.29 lb/acre per 1 lb P_2O_5 fertilizer). Thus, data suggest that 3.5 to 17 lb P_2O_5/acre fertilizer are required to increase soil-test P (Mehlich 3, 1:7 extraction ratio) by 1 lb/acre on a Calloway silt loam cropped to continuous corn. The data also show that soil-test P can vary from year to year.

Corn grain yield was significantly increased from K fertilization at the PTBS in 2002 on a soil with a soil-test K of 204 lb K/acre (Table 4). A yield response to applied K at soil-test values above 200 lb K/acre had not been measured during the previous five years in studies conducted at ASU (Table 5). Like P, Mehlich 3-extractable soil K in post-harvest soil samples increased linearly as K fertilizer rate increased at the ASU site (Table 5).

PRACTICAL APPLICATIONS

Results in previous years (Muir and Hedge, 2002) indicate that corn frequently responds to P and K fertilization at soil test levels that currently result in P and K fertilizer recommendations. The results from the 2002 trial indicated similar results for K. Results to date do not show a response to applied P and/or K at soil test levels too high to warrant a recommendation under the current guidelines. Results from six years of P and K calibration trials indicate that current soil test guidelines are accurate in determining P and K fertilizer recommendations for corn produced on Arkansas soils.

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LITERATURE CITED

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Table 1. Influence of P fertilization on corn grain yields in a study conducted at the Pine Tree Branch Station on a Calhoun silt loam with an initial soil-test P of 44 lb P/acre (Mehlich 3, 1:7 extraction ratio) during 2002.

P fertilizer rate	Corn grain yield
(lb P_2O_5/acre)	(bu/acre)
0	106
80	112
120	116
160	98
$LSD_{(0.05)}$	NS[z]

[z] NS = not significant

Table 2. Corn grain yield and soil-test P as affected by P fertilization rate on soils with different initial soil-test P levels for studies from 1997 - 1999 at Arkansas State University, Jonesboro, Arkansas.

Soil-test	Annual P	Soil-test P[y]			Corn grain yield		
P level[z]	fertilizer rate	Initial[xy]	Fall 1997	Fall 1998	1997	1998	1999
	(lb P_2O_5/acre/yr)	(lb P/acre)			(bu/acre)		
Low	0	21	19	17	159	133	142
	35	22	25	23	152	136	152
	70	21	27	22	165	142	164
	140	23	53	27	173	145	153
Medium	0	31	24	20	168	134	148
	35	29	28	22	173	134	151
	70	27	37	23	182	138	164
	140	28	62	30	174	138	165
$LSD_{(0.05)}$		NS	12	3	NS	9	12

[z] The low soil-test P category represents initial Mehlich 3 (1:7 extraction ratio) concentrations of <25 lb P/acre and the medium soil-test P category represents initial Mehlich 3 (1:7 extraction ratio) concentrations of >25 lb P/acre.

[y] Soils extracted with modified Mehlich 3 procedure (1:7 extraction ratio).

[x] Initial soil-test P in Spring 1997 at the beginning of study before P fertilizer was applied.

Table 3. Corn grain yield and soil-test P affected by P fertilizer rate on a Calloway silt loam with different soil-test P concentrations for studies conducted during 2000 and 2001 at Arkansas State University, located in Jonesboro.

	Soil-test P[z,y]		Corn grain yield	
P fertilizer rate	1999	2000	2000	2001
(lb P_2O_5/acre)	(lb Mehlich 3-P/acre)		------ (bu/acre) ----	
0	21	16	185	173
35	26	22	191	187
70	32	29	196	141
140	52	56	198	190
$LSD_{(0.05)}$	5	7	NS[x]	13

[z] Mehlich 3, 1:7 extraction ratio.
[y] Soil samples taken in the Fall of 1999 and 2000.
[x] NS = not significant

Table 4. Influence of K fertilization on corn grain yields in a study conducted at the Pine Tree Branch Station on a Calhoun silt loam with an initial soil-test K of 204 lb K/acre (Mehlich 3, 1:7 extraction ratio) during 2002.

K fertilizer rate	Corn grain yield
(lb K_2O/acre)	(bu/acre)
0	103
70	96
105	103
140	132
$LSD_{(0.05)}$	22

Table 5. Corn grain yield and soil-test K levels as affected by K fertilization on soils with different initial soil-test K levels in studies conducted at Arkansas State University located in Jonesboro, AR.

	Annual K	Soil-test K[z]									
Soil-test	fertilizer		Fall	Fall	Fall	Fall	Corn gain yield				
K level	rate	Initial[y]	1997	1998	1999	2000	1997	1998	1999	2000	2001
	(lb K_2O/acre/yr)	---------- (lb K/acre) ----------					---------- (bu/acre) ----------				
Very low	0	111	72	113	125	103	154	125	136	179	183
	45	106	99	130	182	129	158	128	146	184	199
	90	108	107	139	199	160	169	151	174	198	203
	180	109	144	189	277	166	168	150	156	209	194
Low	0	135	95	126	158	117	169	118	146	191	189
	45	138	106	173	188	119	159	121	140	189	198
	90	133	109	157	189	127	150	138	160	203	192
	180	138	158	228	291	199	182	131	161	211	198
Medium	0	157	104	147	165	119	176	138	152	186	188
	45	165	113	158	210	144	184	133	155	195	167
	90	162	139	173	242	144	181	150	161	196	195
	180	159	187	238	294	241	164	147	169	197	192
High	0	226	121	151	200	129	177	147	160	187	178
	45	195	128	164	213	131	183	127	167	192	181
	90	204	160	214	280	172	183	143	163	181	176
	180	245	212	280	333	232	179	135	150	180	154
$LSD_{(0.05)}$		11	25	21	25	28	NS[x]	NS	NS	NS	NS

[z] Mehlich 3, 1:7 extraction ratio.
[y] Spring 1997.
[x] NS = not significant