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Crop and Soil Responses to Phosphorus and Potassium

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Abstract
Producers in southeast Iowa are interested in managing available soil phosphorus (P) and potassium (K) to achieve optimum grain yields. This study was established in 1989 to examine P and K management in a corn-soybean crop rotation. In 2001, a nitrogen (N) treatment was added to supply this nutrient to corn at moderate and high rates to determine if corn yields were affected by P and K management.

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Crop and Soil Responses to Phosphorus and Potassium

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Introduction

Producers in southeast Iowa are interested in managing available soil phosphorus (P) and potassium (K) to achieve optimum grain yields. This study was established in 1989 to examine P and K management in a corn-soybean crop rotation. In 2001, a nitrogen (N) treatment was added to supply this nutrient to corn at moderate and high rates to determine if corn yields were affected by P and K management.

Material and Methods

Soil samples from the experimental area were collected in 1989 and determined to be acid; pH's ranged from 5.5–6.0. The area was limed in 1989. Soil test values in 1999 and 2000 were again acid, and the area was limed again in the winter of 2001. The initial 1989 soil test P and K values were determined to be high throughout the experimental area. Plots were laid out 20 feet wide and 45 feet long. Corn and soybeans are grown each year with fertilizer treatments applied biannually at double the annual rate only where soybeans were grown each year. The annual P and K rates are 0, 10, 20, and 30 and 0, 30, 60, and 120 lbs/acre, respectively. In 2001 and 2002, one-half of each 20-foot, 8-row wide corn plot was treated with 100 or 150 lbs N/acre. Thirty-two percent solution N was used each year. It was broadcast applied in 2001 and side-dress applied in 2002. Corn and soybean harvest grain weight and moisture contents are collected on the combine. From these data, standard moisture content adjusted grain yields are calculated.

Results and Discussion

Table 1 presents recent soil test values. Each year's results were obtained from samples collected after soybean harvest and therefore come from different sides of the experimental area. Although the experimental area had been limed in 2001, soil pHs were still acid. This is to be expected because limestone may take up to 3 years to react with acid soil before maximum possible pH is reached. The zero P rate soil test values are all very low and the 10 and 20 lb/acre rates are low. Optimal and very high soil test P values are being maintained with 30 lbs of P/acre. Optimal soil test K values have been maintained without additional K fertilizer. With K fertilizer, high and very high soil test K values have been maintained.

Table 2 presents yield summaries for corn and soybeans grown in 2001 and 2002. Corn yields in 2001 were erratic, and the yield response difference between 100 and 150 lbs N were also unpredictable with an average yield gain of six bushels. In 2002, greater yields were obtained and significantly greater yield increases were noted from an additional 50 lbs of N. In 2002, statistical analysis of yield data found the corn yields increased significantly by the first addition of P and K. This increase was expected from P because of its very low soil test levels but was unexpected from K because its soil test levels were optimal.

Soybean yields responded significantly to P and K treatments in 2002 but not in 2001. As noted in corn, yield increases were obtained from the first increment of added P and K.

Table 1. Recent soil test values.

Treatment		2001				2002			
P	K	$pH_{1:1}$ [a]	pH_{SMP} [b]	P	K	$pH_{1:1}$ [a]	pH_{SMP} [b]	P	K
lbs per $acre^{-1}$				ppm				ppm	
0	0	6.1	6.8	6	147	6.4	6.7	2	144
10	0	6.2	6.9	10	154	6.3	6.5	7	148
20	0	6.1	6.8	15	142	6.4	6.7	20	154
30	0	6.2	6.9	24	139	6.3	6.6	35	168
0	30	6.3	6.9	6	152	6.5	6.6	1	163
10	30	6.2	6.9	7	161	6.3	6.7	9	150
20	30	6.2	6.9	19	167	6.5	6.7	17	165
30	30	6.1	6.8	21	149	6.5	6.5	33	163
0	60	6.2	6.9	5	161	6.4	6.6	3	179
10	60	6.3	6.9	11	167	6.4	6.6	9	173
20	60	6.2	6.9	15	155	6.5	6.7	23	196
30	60	6.1	6.9	24	182	6.3	6.6	28	173
0	90	6.2	6.8	6	171	6.5	6.8	4	212
10	90	6.2	6.8	11	192	6.4	6.6	20	188
20	90	6.1	6.8	23	182	6.4	6.5	21	194
30	90	6.2	6.9	20	168	6.2	6.5	33	200
Simple statistics of all data									
Maximum		6.4	7.1	36	216	6.8	6.8	57	236
Minimum		5.9	6.6	2	114	6.1	6.2	0	136
Average		6.2	6.8	14	162	6.4	6.6	17	173
Standard deviation		0.1	0.1	8	25	0.1	0.1	14	24

[a] $pH_{1:1}$ = pH of solution with equal parts water and soil.
[b] pH_{SMP} = buffer pH.

Table 2. Corn and soybean yield response to P and K at two N application rates.

Treatment		Corn						Soybeans	
		2001			2002				
P	K	N=100	N=150	$N_{increase}$	N=100	N=150	$N_{increase}$	2001	2002
lbs per acre^{-1}					Bushels per acre				
0	0	143	149	6	144	151	7	60.4	49.9
10	0	160	174	14	151	161	10	62.7	50.4
20	0	153	161	8	164	153	-11	58.3	55.1
30	0	155	158	3	138	160	22	60.5	56.4
0	30	166	170	5	162	172	9	58.7	52.6
10	30	159	168	9	182	181	-1	61.2	57.9
20	30	165	172	7	179	196	17	62.7	58.4
30	30	170	175	5	179	195	16	62.7	59.3
0	60	150	153	3	160	179	19	59.4	51.6
10	60	175	178	3	190	177	-13	59.6	59.6
20	60	178	191	13	197	214	16	64.6	63.5
30	60	168	175	7	182	178	-4	63.4	63.4
0	90	166	168	1	166	176	10	58.7	60.2
10	90	165	170	5	187	208	21	65.0	60.0
20	90	159	169	10	181	203	22	59.4	58.6
30	90	169	170	0	185	195	9	65.4	62.4
Simple statistics of all data									
Maximum		178	191	14	197	214	22	69.2	64.6
Minimum		143	149	0	138	151	-13	47.9	41.7
Average		163	169	6	172	181	9	61.5	57.5
Standard deviation		9	10	4	17	19	11	4.4	5.6