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Rotational Corn and Soybean Responses to P and K

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Abstract
Although southeast Iowa soils are generally very productive, phosphorus (P) and potassium (K) must be replenished in them to sustain acceptable crop yields. This study was initiated at the Southeast Iowa Research Farm to examine yield response to these nutrients where each is applied with the other in all combinations ranging from very inadequate (none) to sufficient. Corn and soybeans are grown in alternative years, a common crop rotation practiced in southeast Iowa.

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Introduction

Although southeast Iowa soils are generally very productive, phosphorus (P) and potassium (K) must be replenished in them to sustain acceptable crop yields. This study was initiated at the Southeast Iowa Research Farm to examine yield response to these nutrients where each is applied with the other in all combinations ranging from very inadequate (none) to sufficient. Corn and soybeans are grown in alternative years, a common crop rotation practiced in southeast Iowa.

Materials and Methods

The site at the research farm is Field 5 near the farm's western boundary. The primary soil unit in this field is Mahaska silty clay loam. In the summer of 1989, plots were laid out to accommodate four rates of P and four rates of K that are combined into 16 factorial treatments as shown in Tables 1 to 3. Before the experiment began, soil tests indicated values of each nutrient were generally high. Therefore, 0, 10, 20, and 30 lb P and 0, 30, 60 and 90 lb K per acre average annual application rates were selected. Nitrogen is applied to the corn crop at a rate of 100 lb per acre. The plots are arranged in eight ranges, each is 45 ft long, and the plots are 20 ft or eight rows wide. Corn and soybean plots are combine harvested with grain weights and moisture content collected in the field. Soil samples are collected every other year only from the plots where soybeans had grown. Phosphorus and K fertilizer treatments are applied in the fall to the plots following soybeans. This application strategy requires P and K rates to be twice the average annual application rates listed previously.

Results and Discussion

Soil test data shows that an annual P application rate of 20 lb per acre is maintaining soil test values for this nutrient; 30 lb per acre is increasing P soil test values. Throughout the eleven years of the experiment, there has been a steady decline in K soil test values although the greatest K rate, 90 lb per acre, remains more than sufficient for adequate crop production. Corn and soybean grain yield data are given in Tables 1 and 2, respectively. Corn yields in 1998 were greatly affected by "Green-snap" caused by an extreme storm event when strong "line-winds" occurred. It was interesting to note that only in 1998, did corn plots receiving no K yield more grain than others that received K. Soybean grain yields generally increased more with increasing P and K applications. The 1998 storm event caused marginal damage to the soybean crop. A comparison of crop yields relative to the yearly means was undertaken to determine the consistency of fertility responses. These data are presented in Table 3 for both crops. It is interesting to note that this analysis indicates that P and K rates above 20 and 60 lb per acre, respectively, are needed to support corn yields above the annual mean. Like corn, soybeans are more responsive to both P and K.

Acknowledgments

The late John Webb helped plan this experiment and assisted during the first soil sampling in 1989. This study would not have been possible without the efforts of Southeast Research Farm staff.

Table 1. Corn response to P and K treatments, 1996 to 2000.

P	K	1996	1997	1998	1999	2000	Five-year ave.
Average annual rate lbs per acre		---------- bushels per acre ----------					
0	0	130	128	108	133	167	133
10	0	143	145	103	147	158	139
20	0	147	155	90	147	165	141
30	0	133	144	88	146	174	137
0	30	148	142	82	142	168	136
10	30	145	152	83	145	170	139
20	30	163	155	70	153	152	139
30	30	157	165	53	145	172	138
0	60	149	145	71	129	164	132
10	60	150	154	63	150	168	137
20	60	140	159	68	142	174	137
30	60	133	159	73	146	148	132
0	90	135	157	80	145	166	136
10	90	141	163	55	147	178	137
20	90	150	154	63	149	175	138
30	90	149	156	61	151	165	136
	Averages	144	152	76	145	166	137

Table 2. Soybean response to P and K treatments, 1996 to 2000.

P	K	1996	1997	1998	1999	2000	Five-year ave.
Average annual rate lbs per acre		---------- bushels per acre ----------					
0	0	43.3	42.8	49.2	53.4	55.1	48.8
10	0	44.5	46.3	49.7	52.2	49.4	48.4
20	0	49.2	42.0	49.4	52.1	48.8	48.3
30	0	47.8	46.0	49.1	53.2	47.4	48.7
0	30	46.3	43.0	50.8	53.1	49.1	48.5
10	30	47.2	43.1	47.4	55.5	48.8	48.4
20	30	47.9	45.6	50.8	56.0	48.8	49.8
30	30	49.9	44.8	49.7	55.5	49.2	49.8
0	60	48.5	44.9	47.9	54.6	51.7	49.5
10	60	50.1	44.3	50.5	54.4	50.6	50.0
20	60	49.6	45.3	51.2	57.3	50.7	50.8
30	60	50.2	48.4	53.8	56.0	50.4	51.8
0	90	50.6	43.0	48.7	53.8	52.2	49.6
10	90	51.3	45.7	50.3	56.0	52.0	51.1
20	90	51.5	49.0	47.9	56.7	51.6	51.3
30	90	52.7	45.1	51.0	56.6	52.3	51.5
	Averages	48.8	44.9	49.8	54.8	50.5	49.8

Table 3. Relative yearly crop yields compared with yearly mean yields.

P	K	1996	1997	1998[a]	1999	2000	Five-year ave.
Average annual rate lbs per acre				Corn			
0	0	0.89	0.95	.	0.98	1.09	0.98
10	0	0.91	1.03	.	0.95	0.98	0.97
20	0	1.01	0.93	.	0.95	0.97	0.96
30	0	0.98	1.02	.	0.97	0.94	0.98
0	30	0.95	0.96	.	0.97	0.97	0.96
10	30	0.97	0.96	.	1.01	0.97	0.98
20	30	0.98	1.01	.	1.02	0.97	1.00
30	30	1.02	1.00	.	1.01	0.97	1.00
0	60	0.99	1.00	.	1.00	1.02	1.00
10	60	1.03	0.99	.	0.99	1.00	1.00
20	60	1.02	1.01	.	1.05	1.00	1.02
30	60	1.03	1.08	.	1.02	1.00	1.03
0	90	1.04	0.96	.	0.98	1.03	1.00
10	90	1.05	1.02	.	1.02	1.03	1.03
20	90	1.06	1.09	.	1.03	1.02	1.05
30	90	1.08	1.00	.	1.03	1.04	1.04
				Soybeans			
0	0	0.89	0.95	0.99	0.98	1.09	0.98
10	0	0.91	1.03	1.00	0.95	0.98	0.97
20	0	1.01	0.93	0.99	0.95	0.97	0.97
30	0	0.98	1.02	0.99	0.97	0.94	0.98
0	30	0.95	0.96	1.02	0.97	0.97	0.97
10	30	0.97	0.96	0.95	1.01	0.97	0.97
20	30	0.98	1.01	1.02	1.02	0.97	1.00
30	30	1.02	1.00	1.00	1.01	0.97	1.00
0	60	0.99	1.00	0.96	1.00	1.02	0.99
10	60	1.03	0.99	1.01	0.99	1.00	1.00
20	60	1.02	1.01	1.03	1.05	1.00	1.02
30	60	1.03	1.08	1.08	1.02	1.00	1.04
0	90	1.04	0.96	0.98	0.98	1.03	1.00
10	90	1.05	1.02	1.01	1.02	1.03	1.03
20	90	1.06	1.09	0.96	1.03	1.02	1.03
30	90	1.08	1.00	1.02	1.03	1.04	1.03

a. In 1998, corn plots suffered excessive storm damage and were not included in the analysis.