

# 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 and 2006, nitrogen (N) treatments were added to supply this nutrient to corn at low and moderate rates to determine if corn yields were affected by P and K levels in the soil.

## Materials and Methods

The study area consists of 96 plots, each 8 rows (20 ft wide × 45 ft long). Forty-eight corn and 48 soybeans plots are rotated each year. Soil samples 0–6 inches deep are collected following the soybean harvest. After soil sampling is completed, P and K treatments are applied where soybeans had grown. No fertilizer treatments are applied where corn was grown. Fertilizer treatments consist of a complete factorial combination of 0, 20, 40, and 60 lb of P and 0, 60, 120, and 180 lb of K, respectively. On an annual basis, the rate of application is one-half these amounts.

In 2001 and 2006, one-half of each plot received a low and a moderate rate of nitrogen application. A 50 lb/acre of N differential was used both years. In 2001, the N-rates were 100 and 150 and in 2006 the rates were 80 and 130 lb N/acre. The farm staff did all farming operations and harvested the plots with a scales and moisture meter equipped combine.

## Results and Discussion

Soil test results for plant available P and K are shown in Table 1. For a Mahaska silty clay loam soil P-fertility classes are low (L) at 6–10, optimum (Opt) at 11–15, high (H) at 16–20 and

very high (VH) at greater than 20 ppm P. Potassium soil test classes are Opt at 111–150, H at 151–180 and VH at greater than 180 ppm K. A Mahaska silty clay loam soil possesses subsoil well supplied with P and K. Soil test P-levels remained nearly constant without P-addition through the five years reported and have increased with annual applications of ten or more lb of P/acre. Soil test K-levels remained in the Opt range where no K was applied and increased with all rates greater than zero. Reserves of plant available P and K in the subsoil helped maintain soil test levels and prevented large declines within this 5-year period.

Corn yield responses to N, P, and K treatments and increases from the 50-lb N addition are shown in Table 2 and 3, respectively. In both 2001 and 2006, corn responded to the first addition of P and K. This is expected because the first increment of P satisfied the crop's needs for this nutrient. Having a differential of 50 lb of N/acre provides important insight into adjusting N-application for corn on this and similar soils used in a corn-soybean rotation. In 2001, 11 of the 16 PK treatments had yield increases greater than 5 bushels/acre and in 2006, 13 of 16 had a five or greater bushel/acre yield increase. The average yield increase was 6 and 14 bushels/acre in 2001 and 2006, respectively. The greater yield increase in 2006 occurred using 20 lb less N than in 2001. These data indicate that a producer can use a test strip with a 50-lb N reduction to determine if the full N-rate results in a yield increase.

## Acknowledgments

This study could not have been done without the assistance Mr. Russell Doorenbos in both field sample collection and laboratory analysis and the Southeast Research and Demonstration Farm staff who carried out farming and harvest operations.

**Table 1. Soil test results for 2001 and 2006 crop plots.**

Annual P-rate	Annual K-rate, lb/acre							
	0	30	60	90	0	30	60	90
Lb/acre	<u>2001 soil test levels, ppm P</u>				<u>2006 soil test levels, ppm P</u>			
0	7	8	7	8	9	9	8	8
10	10	8	12	11	16	15	17	17
20	15	18	16	19	31	34	28	36
30	22	19	22	25	54	54	57	50
	<u>2001 soil test levels, ppm K</u>				<u>2006 soil test levels, ppm K</u>			
0	126	135	147	159	134	147	176	215
10	131	143	143	167	136	155	163	210
20	133	142	137	161	130	146	166	202
30	129	137	147	154	131	146	180	202

P and K applied bi-annually after the soybean harvest at twice annual rate.

**Table 2. Corn response to N, P, and K fertility treatments in 2001 and 2006.**

Annual P-rate	Annual K-rate, lb/acre							
	0	30	60	90	0	30	60	90
Lbs/acre	2001 yield, bushels/acre				2006 yield, bushels/acre			
	----- 100 lb N/acre -----				----- 150 lb N/acre -----			
0	143	166	150	166	149	170	153	168
10	160	159	175	165	174	168	178	170
20	153	165	178	159	161	172	191	169
30	155	170	168	169	158	175	175	170
	----- 80 lb N/acre -----				----- 130 lb N/acre -----			
0	168	188	171	181	191	193	200	186
10	176	189	183	193	192	209	197	209
20	187	194	207	204	189	213	211	214
30	183	202	194	192	202	202	203	219

**Table 3. Yield increase from additional N in 2001 and 2006.**

Annual P-rate	Annual K-rate, lb/acre							
	0	30	60	90	0	30	60	90
Lb/acre	----- 2001 bushels/acre -----				----- 2006 bushels/acre -----			
0	6	5	3	1	23	5	29	5
10	14	9	3	5	16	20	15	16
20	8	7	13	10	2	19	4	10
30	3	5	7	0	19	0	9	28