

# Corn, Soybean, and Soil Responses to Phosphorus Fertilizer

Stan Henning, assistant professor  
Department of Agronomy

## Introduction

This study was conducted to determine crop and soil test responses to phosphorus (P) fertilizer on a soil determined to be responsive to this nutrient. Specifically, we wanted to determine which of five soil extractants would best determine plant available P.

## Materials and Methods

Soil samples were collected to a depth of six inches from the designated plot area and analyzed at the Iowa State University Soil Testing and Plant Analysis Laboratory and Henning's lab in Agronomy Hall. The results were used to determine phosphate application rates for corn and soybean crops. Diammonium phosphate (18-46-0) was broadcast applied by hand to plots 15 ft wide × 50 ft long. Three rates of phosphate and a check were replicated four times with each test crop. The Northwest Farm staff planted the crops and applied herbicides and cultivated as needed. Alleyways were cut to yield plots 45 ft long. Prior to corn harvest, ear and stalk samples were collected from six plants. These were transported to Ames to be processed to enable grain and stalk analyses. The plots were combine harvested and weight and moisture contents were obtained during harvest. Because the corn plots were lodged from the August windstorm, all plots were harvested in one direction. The soybean crop sustained no lodging damage from wind and was harvested in both directions.

## Results and Discussion

Table 1 summarizes the harvest data for both crops. Yield increases were observed to

increasing P-application rates. Corn leaf and stalk compositions are shown in Table 2. Although slight N, P, K content increases occurred in corn leaves, they were not statistically significant. Corn stalk P and N composition tended to increase with increasing P-rate but were statistically insignificant. Chloride content in the corn stalk increased markedly with increasing P-rate. This was not expected but could be explained if chloride is a major contaminant in diammonium phosphate.

Table 3 summarizes P-soil test data from soil samples taken before application and after the crops were harvested. Each of the extractants evaluate inorganic P in the soil but have different extracting abilities. Bray1 (B1) is commonly used when soil pHs are less than 7.4. Bray2 (B2) is a stronger extractant and dissolves P-bearing minerals that B1 will not dissolve. Mehlich3 (M3) is considered to be a universal soil extractant because it extracts many other nutrients in addition to P. Morgan (M) is often used in field kits and is also considered a universal extractant for many nutrients. The Olsen solution was developed for soils with a pH greater than 7 but it can be used successfully at a slightly lower pH. The soil in the test plots was acid, ranging in pH from 5.8 to 6.5. Statistically, B1 was the only extractant that showed increases in plant available P with increasing P applications.

## Acknowledgments

This experiment was conducted with the assistance of Mr. Russell Doorenbos during sample collection and laboratory analysis and with the help of the Northwest Research and Demonstration Farm staff.

**Table 1. Corn and soybean response to phosphorus fertilizer.**

P <sub>2</sub> O <sub>5</sub> rate lb ac <sup>-1</sup>	Corn harvest		Soybean harvest		
	Moisture %	Yield bu ac <sup>-1</sup>	P <sub>2</sub> O <sub>5</sub> rate lb ac <sup>-1</sup>	Moisture %	Yield bu ac <sup>-1</sup>
0	16.1	132	0	11.0	43.4
38	16.1	147	30	11.0	47.7
75	16.2	152	60	11.0	50.3
113	16.2	154	90	11.1	51.1
Standard deviation	0.1	13		0.2	4.4

All data is the average of four replications

**Table 2. Corn leaf and stalk composition response to phosphorus fertilizer.**

P <sub>2</sub> O <sub>5</sub> rate lb ac <sup>-1</sup>	---- Corn leaf composition at silking ----				----- Corn stalk composition -----				
	N	P	K	Zn	F	Cl	N	P	S
	----- percent -----				----- mg Kg <sup>-1</sup> -----				
0	2.27	0.14	0.90	10.5	271	380	929	142	2,256
38	2.24	0.15	0.91	7.1	259	428	1,336	154	2,085
75	2.24	0.16	0.98	12.1	289	546	1,069	181	1,966
113	2.34	0.17	0.99	8.0	276	610	1,015	170	1,783
Standard deviation	0.20	0.03	0.07	5.9	59	135	280	32	291

All data is the average of four replications

Leaf composition is total phosphorus (P), potassium (K), zinc (Zn) and nitrogen (N).

Corn stalk composition is fluoride (F), chloride (Cl), nitrate-N, phosphate (PO<sub>4</sub>)-P, and sulfate (SO<sub>4</sub>)-sulfur (S)

**Table 3. Soil test response to phosphorus fertilizer.**

P <sub>2</sub> O <sub>5</sub> rate lb ac <sup>-1</sup>	B1	B2	M3	M	Olsen	B1	B2	M3	M	O
	-----mg Kg <sup>-1</sup> -----									
<u>Corn</u>	-----Pre-application sampling-----					-----Post-harvest sampling-----				
0	7	15	20	1.4	13	7	14	7	2.3	11
38	6	15	18	1.4	14	10	20	10	2.4	13
75	7	16	21	1.6	14	11	21	12	2.9	14
113	6	14	20	1.5	14	21	32	24	3.3	20
Standard deviation	2	3	6	0.4	3	6	8	7	1.0	5
<u>Soybeans</u>										
0	7	16	20	1.4	16	10	16	8	1.8	15
30	7	15	21	1.4	17	13	21	2	2.1	17
60	8	17	22	1.5	17	14	22	13	2.2	16
90	8	17	23	1.5	15	28	35	28	2.3	23
Standard deviation	2	3	5	0.3	2	10	10	11	1.2	6

All data is the average of four replications

Extractants are B1=Bray1, B2=Bray2, M3=Mehlich3, M=Morgan, and O=Olsen.