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Corn, Soybean, and Soil Responses to Phosphorus Fertilizer

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Abstract
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.

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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.

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Table 1. Corn and soybean response to phosphorus fertilizer.

	Corn harvest			Soybean harvest	
P_2O_5 rate	Moisture	Yield	P_2O_5 rate	Moisture	Yield
lb ac^{-1}	%	bu ac^{-1}	lb ac^{-1}	%	bu ac^{-1}
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.

	---- Corn leaf composition at silking ----				---------- Corn stalk composition ----------				
P_2O_5 rate	N	P	K	Zn	F	Cl	N	P	S
lb ac^{-1}	--------- percent ----------			mg Kg^{-1}	---------- mg Kg^{-1} ----------				
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_4)-P, and sulfate (SO_4)-sulfur (S)

Table 3. Soil test response to phosphorus fertilizer.

P_2O_5 rate	B1	B2	M3	M	Olsen	B1	B2	M3	M	O
lb ac^{-1}	----------mg Kg^{-1}----------									
Corn	----------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
Soybeans										
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.