Corn, Soybeans, and Soil Test Response to Lime and Hoop Building Manure

Stanley Henning, assistant professor
Department of Agronomy

Introduction

In 1995, a liming study was initiated at the Armstrong Farm where acid topsoil had developed from extensive nitrogen (N) fertilizer use in continuous corn (CC) production without liming. In 2003, the experimental area was divided into thirds; a corn-soybean (CSb) rotation occupied two-thirds of the area and CC occupied the remaining third. Hoop building cattle manure was incorporated into the experiment beginning in 2006 to evaluate soil acidity effects on nutrient utilization by crops in both crop rotations and also on soil test values. Manure was applied again in the fall of 2006 to where corn and soybeans would be grown in 2007 to evaluate its effects on both crops as well as soil test values.

Material and Methods

Soil testing conducted in 1994 indicated that the amount of lime required to raise soil pH to 6.5 in this area was 15,000 lb/acre of effective calcium carbonate equivalent (ECCE). In April 1995, ag-lime was applied to maintain an un-limed control and to achieve target pHs of 5.5, 6.0, 6.5, and 7.0. Hoop building cattle manure was applied in the fall of 2006 at an application rate of 11 tons/acre. After manure was applied, no tillage was done until spring. In the spring, light tillage was undertaken, corn and soybeans were planted, and herbicides applied; no other in-season cultivation was done. Corn and soybeans were harvested with grain weights and moisture content recorded.

Results and Discussion

Soil test data are presented in Table 1. The soil test results were from soil cores taken to a depth of 10 in. Plant available P increased with soil pH for both the Bray1 and Olsen extractants although the latter increased more than the Bray1. This is expected as Bray1 and Olsen extractants are intended for use in acid and alkaline soils, respectively. Interpretation of P-soil test values indicated that a majority of plots tested vary with only extreme pHs causing *low-value* interpretation when the inappropriate extracting solution was used. All the soil test K values placed the entire plot area into the *very high* range.

Soil test ammonium-N decreased with increasing soil pH whereas nitrate-N increased in the CC plots, but not the CSb plots. Increasing soil pH enhances volitazation losses of ammonium-N. However, increasing soil pH should increase nitrate-N content of soil. In this study, nitrate-N responses were inconsistent.

Table 2 shows crop responses to liming. Corn responses can be contrasted between N-fertilizer and manure as well. Corn grown in CSb rotation responded more markedly to fertilizer and manure than CC-corn. In CC, the greater N-rate increased moisture content but not as greatly as manure. In CSb, grain moisture was unaffected by either N-rate or manure. Corn grain yields generally were increased by increasing lime applications.

Soybean moisture content was generally unaffected by lime or manure treatments as were yields where no manure was applied. Manure increased yields with increasing lime applications, but the increase was no more than 2 to 4 bushels/acre from the lowest to the highest ECCE-rate.

Manure application was beneficial to both corn and soybeans. Its ability to increase yields was enhanced by liming that had increased soil pH to 6.5 to 7.0. Soil test P and K levels were also increased to such an extent that manure application in sequential years should be avoided to allow for crop removal of excess nutrients. Corn would be expected to remove a greater amount of N than soybeans. An inspection of soybean nodules during late pod-fill indicated that without manure, they were both firm and functioning with a reddish color when nodules were split. With manure, the nodules were soft, and when the nodules were split they appeared whitish and without function.

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Table 1. Late-spring nitrate-N soil responses to lime and manure treatments in 2007, 10-in. soil cores.

Lime rate	pH_{water}		NH_4-N		NO_3-N		Bray1-P		Olsen-P		K	
	CC	CSb	CC	CSb	CC	CSb	CC	CSb	CC	CSb	CC	CSb
tons acre^{-1}			mg Kg^{-1}									
0	5.5	5.5	5.6	5.1	23	24	43	38	21	18	357	303
1.7	6.1	5.7	3.8	4.2	23	22	34	40	19	21	371	344
5	6.1	5.9	4.1	4.2	22	16	44	32	18	16	335	304
15	6.6	6.8	3.8	3.6	27	19	47	39	27	23	410	407
45	7.3	7.1	3.5	3.7	27	20	37	42	33	28	349	321
Maximum	7.4	7.4	8.3	5.6	33	35	73	68	49	47	663	588
Minimum	5.2	5.2	3.0	2.9	17	11	26	21	13	11	287	242
Average	6.0	5.9	4.2	4.2	24	20	41	38	24	21	364	336

Table 2. Crop responses to rotation, lime, and manure in 2007.

Lime rate	Corn summary						Soybean summary			
tons acre^{-1}	N, lb/acre^{-1}			N, lb/acre^{-1}						
	100	150	Manure	100	150	Manure	No manure	Manure	No manure	Manure
	Grain moisture, %			Yield, bu/acre^{-1}			Grain moisture, %		Yield, bu/acre^{-1}	
Corn-soybean rotation										
0	16.4	16.5	16.5	183	198	210	12.0	12.7	65.3	66.8
1.7	16.1	16.1	16.4	187	202	213	12.2	12.5	66.4	67.2
5	15.8	16.3	16.6	178	197	210	12.1	12.3	65.7	64.0
15	16.4	16.1	16.3	188	211	213	12.3	12.2	66.2	70.4
45	16.1	16.1	16.6	185	205	211	11.9	12.5	65.1	68.8
Simple statistics[1]										
Maximum	17.1	17.8	16.9	211	228	233	13.7	13.0	71.3	71.6
Minimum	15.6	15.8	16.1	164	180	192	12.0	11.8	59.8	48.8
Average	16.2	16.2	16.5	184	202	211	12.4	12.1	65.7	67.5
Continuous corn										
0	15.9	15.9	16.5	178	187	196				
1.7	15.8	16.0	16.5	172	194	194				
5	15.7	15.9	16.4	180	192	198				
15	15.8	15.9	16.6	182	193	197				
45	15.9	16.0	16.4	181	193	200				
Simple statistics[1]										
Maximum	16.3	16.3	17.3	201	213	212				
Minimum	15.4	15.7	15.7	165	173	178				
Average	15.8	15.9	16.5	179	192	197				

[1]Calculated from four replications.