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Crop and Soil Responses to Rates of Lime

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Abstract
Grain producers in northeast Iowa are interested in the effects of liming rates on crops and soils. Currently, it is recommended that a corn-soybean rotation requires a soil pH of 6.5. This experiment was designed to determine the effects of liming rate on soil pH and a corn-soybean rotation that is under-, adequately, and over-limed according to this recommendation.

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Introduction

Grain producers in northeast Iowa are interested in the effects of liming rates on crops and soils. Currently, it is recommended that a corn-soybean rotation requires a soil pH of 6.5. This experiment was designed to determine the effects of liming rate on soil pH and a corn-soybean rotation that is under-, adequately, and over-limed according to this recommendation.

Materials and Methods

Corn and soybean crops are grown in alternate years on a Kenyon soil. Before the experiment began in 1984, the soil was acid with a pH of 5.5. At that time, a one-time application of ag-lime from a local quarry was hand applied at rates of 0; 1,000; 2,000; 4,000; 8,000; 12,000; and 16,000 lb effective calcium carbonate equivalent (ECCE) per acre. Tillage followed application. At pollination, six corn leaves were collected in each plot. These were dried, ground, and analyzed for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and zinc (Zn) contents. After corn harvest in early November, soil samples were collected to a depth of 6 inches in each plot and analyzed to determine soil acidity (pH), lime requirements, available P by two methods, and exchangeable cations (Ca, Mg, and K), and Zn. Hydrogen (H) ion concentration was calculated by using Equation 1. Cation exchange capacity (CEC) was calculated by summation of cations.

$$H_{meq} = 12 \text{ X } (7\text{-}pH_{buffer}) \qquad [1]$$

Results and Discussion

Soils. Soil test and leaf analysis data are from 2009 samples (Table 1). In this and the other tables, reported values are averages of four replications of each lime rate treatment. Where no liming occurred, soil acidity has declined only slightly from an initial 5.5 pH. As greater liming or ECCE rates increased, soil acidity declined (pH increased). Soil test available P increases with soil pH regardless of the extracting solution used. Soil Ca and Mg increase directly with ECCE rate and calculated H ion concentration declines. Soil test K and Zn remained constant at all pH levels. Corn leaf P, Ca, and Mg contents reflect the amounts each element measured by soil tests. Corn leaf N, K, and Zn contents were adequate and generally unaffected.

Crops. Recent corn and soybean responses are given in Tables 2 and 3, respectively. These data show that each crop responds positively to increasing soil pH. Several corn crop-years' data show that silking date is as much as two days earlier and yield is greatest with increasing soil pH up to the greatest ECCE application. The earlier the silking date, the lower corn grain moisture. In fact, reduced moisture content was over 3%. Achieving the lowest possible grain moisture content at harvest will reduce drying costs. Soybean grain moisture is generally unaffected by soil acidity; maximum grain yields are achieved with 4,000 to 8,000-ECCE applications where soil pHs range from 5.8 to 6.2. Based on these results, grain producers should lime soil to a pH of 6.9 to obtain 1) an earlier silking date that will lower grain moisture at harvest, and 2) produce the greatest possible yield.

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Table 1. Post-harvest soil and silking corn leaf sample responses to rates of lime in 2009.

ECCE	pH	Bray1 P	Olsen P	Ca	Mg	P	Ca	K	Mg
lbs/ac			---------- Soil, mg/kg ----------				---------- Leaf, % ----------		
0	5.18	33.2	7.0	1,165	187	0.26	0.30	1.41	0.20
1,000	5.34	35.1	7.3	1,233	204	0.27	0.31	1.45	0.20
2,000	5.37	32.9	6.9	1,423	232	0.27	0.31	1.47	0.21
4,000	5.57	29.7	6.6	1,543	253	0.27	0.33	1.44	0.22
6,000	5.93	28.6	6.3	1,633	281	0.28	0.33	1.48	0.24
8,000	6.15	27.9	7.6	1,743	307	0.27	0.32	1.48	0.23
12,000	6.38	35.6	9.5	1,870	342	0.28	0.34	1.46	0.25
16,000	6.93	37.0	11.0	1,988	368	0.29	0.34	1.45	0.25

Table 2. Recent corn responses to rate lime.

ECCE	2009	2007	2005	2003	2001	1999	Avg.
lb/ac		---------- Silking, month and date ----------					
0	7/26	7/19	7/21	7/21	7/21	7/18	7/21
1,000	7/26	7/20	7/21	7/21	7/21	7/18	7/21
2,000	7/26	7/20	7/20	7/21	7/21	7/18	7/21
4,000	7/26	7/19	7/20	7/19	7/20	7/17	7/20
6,000	7/24	7/20	7/20	7/18	7/20	7/17	7/19
8,000	7/25	7/18	7/19	7/18	7/21	7/17	7/19
12,000	7/24	7/18	7/19	7/17	7/21	7/17	7/19
16,000	7/24	7/17	7/19	7/17	7/20	7/18	7/19
		---------- Grain moisture, % ----------					
0	30.0	20.8	21.5	14.8	19.5	20.5	20.9
1,000	28.9	20.7	21.5	14.7	19.8	20.6	20.8
2,000	29.6	20.9	21.4	14.7	19.1	20.3	20.8
4,000	29.3	20.5	21.0	14.5	19.3	20.0	20.6
6,000	27.9	20.5	20.1	14.7	19.4	19.9	20.1
8,000	27.7	20.0	20.6	14.6	19.2	19.9	20.2
12,000	26.9	19.8	20.7	14.8	19.2	19.9	20.2
16,000	26.7	19.8	20.3	14.7	19.2	19.9	20.0
		---------- Corn yield, bushels/acre ----------					
0	218	189	208	129	152	187	182
1,000	225	195	206	125	150	196	183
2,000	223	186	213	128	151	188	184
4,000	229	187	213	128	156	189	187
6,000	238	202	218	134	149	190	189
8,000	245	215	214	139	156	184	191
12,000	241	208	214	138	163	187	191
16,000	250	212	217	144	164	187	195

Table 3. Soybean yield response to rate of lime in recent years.

ECCE	2008	2006	2004	2002	2000	1998	Avg.
lb/ac		---------- Soybean yield, bushels/acre ----------					
0	61.5	59.5	59.6	54.1	52.8	56.9	57.4
1,000	62.1	60.7	60.1	56.9	54.7	59.7	59.0
2,000	62.9	59.3	61.7	56.7	55.1	60.3	59.3
4,000	65.9	60.4	61.3	57.6	57.2	65.0	61.2
6,000	65.1	58.9	62.0	56.3	57.8	64.1	60.7
8,000	65.3	60.6	61.3	57.1	56.3	63.6	60.7
12,000	64.9	60.0	60.5	55.8	55.8	64.0	60.2
16,000	65.1	58.5	58.6	55.4	56.6	63.6	59.6