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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. To achieve maximum alfalfa yields, rotations that include this crop must be limed to a minimum soil pH of 6.9. But, it is recommended that a rotation without alfalfa requires a soil pH of only 6.5. This experiment was designed to determine the effects of liming rate on soil pH for a corn-soybean rotation that is under, adequately, and over limed.

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Introduction

Grain producers in northeast Iowa are interested in the effects of liming rates on crops and soils. To achieve maximum alfalfa yields, rotations that include this crop must be limed to a minimum soil pH of 6.9. But, it is recommended that a rotation without alfalfa requires a soil pH of only 6.5. This experiment was designed to determine the effects of liming rate on soil pH for a corn-soybean rotation that is under, adequately, and over limed.

Materials and Methods

Corn and soybean crops were grown in alternate years on a Kenyon soil. Before the experiment began in 1984, the soil was acid with a pH of 5.5. Agricultural limestone 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. After soybean harvest, soil samples are collected to depth of 6 in. in each plot and analyzed to determine soil acidity (pH), lime requirements, available phosphorus (P) by two methods, and exchangeable cations (calcium–Ca, magnesium–Mg, potassium–K, and sodium–Na). Hydrogen (H) ion concentration is calculated by using Equation 1. Cation exchange capacity (CEC) is calculated by summation of cations.

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

Results and Discussion

Soils. Soil test pH, lime requirements, and P and K results from 2008 samples are shown in Table 1. Reported values are averages of four replications of each lime rate. When no liming occurred, soil acidity had declined only slightly from an initial 5.5 pH. As liming rates increased, soil acidity declined (pH increased) with the increasing ECCE. Soil test available P increases with soil pH regardless of extracting solution. Soil test K remains constant at all pH levels. Soil Ca and Mg contents increase directly with ECCE rate while H ion concentration declines. Fertilizer is bulk applied to all plots each year as recommended by ISU Extension's publication PM-1688, *A General Guide for Crop Nutrient and Limestone Recommendations in Iowa*.

Crops. Recent corn and soybean responses are given in Tables 2 and 3, respectively. These data show that both crops respond to ECCE. Six corn crop-years show that pollination was as much as 2 to 4 days earlier and grain yield increased with increasing soil pH. Grain moisture at harvest decreased as ECCE-rate increased. Soybean grain moisture was generally unaffected by ECCE-rate, but maximum grain yields were achieved with 4,000 to 8,000 ECCE applications where soil pHs ranged from 5.8 to 6.2. Based on these data, row crop producers in northeast Iowa should soil sample for determination of ECCE and nutrient requirements. If only corn and soybeans are being grown, maximum applied ECCE rates should achieve pHs no greater than 6.5.

Acknowledgements

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Table 1. Soil test response to rates of lime (ECCE) in 2008.

			Lime requirement		Soil test P and level*		
ECCE	pH	Buffer pH	6.5	6.9	Bray1	Olsen	Soil test K and level
lb acre^{-1}			ECCE, lb acre^{-1}		ppm**	ppm	ppm
0	5.40	6.27	4,410	7,043	21-**H**	11-**Opt**	201-**VH**
1,000	5.49	6.33	3,969	6,545	29-**H**	15-**H**	217-**VH**
2,000	5.54	6.31	4,061	6,649	20-**Opt**	11-**H**	195-**H**
4,000	5.84	6.54	2,391	4,761	21-**H**	16-**Opt**	207-**VH**
6,000	6.10	6.70	1,161	3,372	19-**Opt**	14-**L**	203-**VH**
8,000	6.21	6.73	940	3,123	22-**H**	14-**L**	197-**H**
12,000	6.64	6.94	-565	1,422	29-**H**	19-**H**	196-**H**
16,000	7.17	7.11	-1,740	95	35-**VH**	23-**VH**	201-**VH**

*Very Low (**VL**), Low, (**L**), Optimum (**Opt**), High (**H**), Very High (**VH**).

**ppm, parts per million.

Table 2. Corn response to rates of lime - effective calcium carbonate equivalent (ECCE).

ECCE	2007	2005	2003	2001	1999	1997	Avg
lb acre^{-1}	---------- Grain yield, bushels acre^{-1} ----------						
0	188.8	208.4	129.2	152.3	187.3	170.4	172.7
1,000	194.6	206.0	125.0	149.5	195.6	171.7	173.7
2,000	185.7	213.4	127.6	150.6	187.6	176.1	173.5
4,000	187.3	213.3	127.7	156.5	189.5	182.0	176.0
6,000	201.7	218.1	134.1	148.6	190.3	178.0	178.5
8,000	215.1	214.4	139.4	156.0	184.0	184.3	182.2
12,000	207.9	214.0	137.6	163.0	186.6	178.2	181.2
16,000	212.3	216.9	144.3	164.1	186.9	183.3	184.6
	---------- Grain moisture, percent ----------						
0	21.5	21.5	14.8	19.5	20.5	19.0	20.1
1,000	21.5	21.5	14.7	19.8	20.6	18.9	20.3
2,000	21.4	21.4	14.7	19.1	20.3	18.9	20.0
4,000	21.0	21.0	14.5	19.3	20.0	19.0	19.9
6,000	20.1	20.1	14.7	19.4	19.9	18.7	19.6
8,000	20.6	20.6	14.6	19.2	19.9	18.8	19.7
12,000	20.7	20.7	14.8	19.2	19.9	19.2	19.8
16,000	20.3	20.3	14.7	19.2	19.9	19.0	19.6

Table 3. Soybean response to rates of lime - effective calcium carbonate equivalent (ECCE).

ECCE	2008	2006	2004	2002	2000	1998	1996	Avg
lb acre^{-1}	---------- Grain yield, bushels acre^{-1} ----------							
0	61.5	59.5	59.6	54.1	52.8	56.9	46.7	55.9
1,000	62.1	60.7	60.1	56.9	54.7	59.7	47.5	57.4
2,000	62.9	59.3	61.7	56.7	55.1	60.3	50.7	58.1
4,000	65.9	60.4	61.3	57.6	57.2	65.0	54.1	60.2
6,000	65.1	58.9	62.0	56.3	57.8	64.1	56.4	60.1
8,000	65.3	60.6	61.3	57.1	56.3	63.6	55.7	60.0
12,000	64.9	60.0	60.5	55.8	55.8	64.0	55.7	59.5
16,000	65.1	58.5	58.6	55.4	56.6	63.6	55.4	59.0