

Crop and Soil Responses to Rates of Lime

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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.

$$H_{\text{meq}} = 12 \times (7 - \text{pH}_{\text{lime requirement}}) \quad [1]$$

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.

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

| ECCE lb acre ⁻¹ | pH | Buffer pH | Lime requirement | | Soil test P and level* | | Soil test K and level |
|-------------------------------|------|--------------|------------------------------------|-------|------------------------|----------------|--------------------------|
| | | | 6.5 ECCE, lb acre ⁻¹ | 6.9 | Bray1 ppm** | Olsen 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 lb acre ⁻¹ | 2007 | 2005 | 2003 | 2001 | 1999 | 1997 | Avg |
|-------------------------------|---|-------|-------|-------|-------|-------|-------|
| | ----- 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 lb acre ⁻¹ | 2008 | 2006 | 2004 | 2002 | 2000 | 1998 | 1996 | Avg |
|-------------------------------|---|------|------|------|------|------|------|------|
| | ----- 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 |