2006

Liming and Nitrogen Management in Corn

Stanley Henning
Iowa State University

Liming and Nitrogen Management in Corn

Abstract
In 1995, a liming study was initiated at the Armstrong Farm where acid soil 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. The goals of this experiment were to determine corn crop and soil responses to liming and crop rotation effects on N management.

Keywords
Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

Liming and Nitrogen Management in Corn

Stanley Henning, assistant professor
Department of Agronomy

Introduction

In 1995, a liming study was initiated at the Armstrong Farm where acid soil 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. The goals of this experiment were to determine corn crop and soil responses to liming and crop rotation effects on N management.

Material and Methods

The 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 application rates of 0, 1.67, 5, 15, and 45 tons/acre were applied to maintain an unlimed control and to achieve target pH of 5.5, 6.0, 6.5, and 7.0. In June of 2005, when corn plants were 10 in. tall, 12-in-deep soil core samples were collected for analysis of soil nitrate NO_3-N and other soil testing parameters. After the soil sample collection, N as anhydrous ammonia was applied in accordance with N reduction guidelines given by the Iowa Soybean Association (ISA). Specifically, the usual N rate and a 50-lb/acre reduced rate were applied in a side-by-side comparison. The usual and reduced N rates for CC were 180 and 130 lb/acre. For corn grown in the CSb rotation, 130 and 80 lb of N/acre were applied.

Corn was harvested from four rows in each plot. Six corn plants were randomly selected from adjacent rows where the ears and a 10-in. cornstalk segment, starting at 6 in. above the soil, were collected. The shelled grain was analyzed at the ISU Grain Quality Laboratory. Cornstalk samples were analyzed for NO_3-N contents at the Iowa State University Soil Testing and Plant Analysis Laboratory. Cornstalk inorganic phosphorus (P) contents were determined by extraction with Bray 1 solution by the author.

Results and Discussion

Soil-test acidity (pH), NO_3-N, P, potassium (K), calcium (Ca), magnesium (Mg), and Ca:Mg ratio responses to lime and crop rotation are shown in Table 1. Ag-lime neutralized the soil acidity as noted by soil pH; the greatest pH change occurred with the 45-ton lime rate. Soil-test P increased when soil pH was greater than 6.0. Nitrate-N content was slightly greater in soil collected where soybeans had been grown in 2004. Calcium absorbed to the soil exchange complex increased and absorbed Mg remained constant with increasing lime rates. This is expected as Ca displaced acidic hydrogen from the soil.

Grain yields and quality, cornstalk NO_3-N, and inorganic P content data are presented in Table 2. Corn yields were greatest at the reduced N rate in both CC and the CSb rotations. However, grain protein and stalk NO_3-N content were highest where the greatest N-rate was applied in each rotation. Cornstalk NO_3-N contents declined with increasing soil pH.

Following the ISA guideline, a 50-lb N reduction did not result in yield loss. In fact, if cornstalk NO_3-N contents are optimal at 2,000 ppm, the CC N rate could be reduced to 125 or 120 lb/acre. However, the N rate for CSb rotation should be increased to 90 or 100 lb/acre to achieve cornstalk NO_3-N contents for optimal corn production.

Acknowledgments

This study could not have been carried out without the assistance of the Armstrong Farm staff, the Iowa Limestone Producers'

Association and Schildberg Construction for arranging and applying limestone, the Iowa Soybean Association, and Russell Doorenbos, who conducted grain quality analysis at the ISU Grain Quality Laboratory supported by the Iowa Grain Quality Initiative.

Table 1. Soil test results of 0–12-in. soil core samples

Lime rate	Acidity	Buffer	NO_3-N	P	K	Ca	Mg	Ca:Mg
(tons/acre)	--------pH---------		---------ppm----------			meq per 100 g		
Continuous corn								
0.0	5.6	6.4	4.7	21	275	8.9	1.2	7.7
1.7	6.0	6.6	3.2	22	281	9.8	1.2	7.8
5.0	6.0	6.6	2.9	22	230	10.3	1.2	8.6
15.0	6.7	7.0	4.2	27	255	11.5	1.2	10.0
45.0	6.9	7.1	3.4	33	231	12.7	1.1	11.7
Corn/soybean rotation								
0.0	5.6	6.4	5.9	24	216	9.2	1.3	7.1
1.7	6.0	6.6	5.1	22	256	10.1	1.3	7.7
5.0	6.0	6.6	4.0	23	204	10.7	1.4	7.9
15.0	6.8	7.0	6.2	34	223	12.1	1.2	9.9
45.0	7.2	.	6.5	31	215	13.6	1.2	11.6

Table 2. Corn response to rotation, nitrogen, and limestone rate in 2005.

		Harvest		Stalk analysis		Grain quality analysis			
Limestone	N rate	Moist.	Yield	NO_3-N	P	Protein	Oil	Starch	Density
(tons/acre)	(lb/acre)	(%)	(bu/acre)	----------ppm--------		-------------(%)---------------			
Continuous corn									
0.0	130	15.7	185	2,950	124	8.6	3.9	59.8	1.29
1.7	130	15.5	186	2,453	85	8.5	3.6	60.1	1.29
5.0	130	15.5	187	2,068	96	8.4	3.8	60.0	1.30
15.0	130	15.5	189	1,968	112	8.5	3.8	60.0	1.29
45.0	130	15.7	185	1,710	125	8.4	3.8	60.0	1.29
0.0	180	16.0	177	5,200	172	8.8	3.8	59.7	1.30
1.7	180	16.0	175	4,665	163	8.8	3.7	59.9	1.29
5.0	180	16.0	185	3,388	139	8.7	3.8	59.8	1.30
15.0	180	16.0	179	3,818	183	8.7	3.8	59.8	1.30
45.0	180	15.8	181	3,335	185	8.8	3.8	59.7	1.30
Corn/soybean rotation									
0.0	80	15.9	184	1,442	118	8.4	3.8	60.0	1.29
1.7	80	16.0	187	1,047	143	8.3	3.9	60.1	1.29
5.0	80	16.0	182	744	159	8.2	3.8	60.1	1.30
15.0	80	15.8	188	1,203	145	8.4	3.9	59.9	1.29
45.0	80	15.8	192	706	171	8.3	3.9	60.0	1.29
0.0	130	15.7	196	3,155	120	8.9	3.9	59.5	1.29
1.7	130	15.9	189	3,673	101	8.7	3.8	59.7	1.29
5.0	130	15.9	195	2,970	96	8.8	3.8	59.7	1.30
15.0	130	16.0	196	2,368	130	8.7	3.8	59.8	1.29
45.0	130	15.9	199	2,823	145	8.8	3.9	59.6	1.29