Liming and Nitrogen Management in Corn

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Introduction

In 1995, a liming study was initiated at the Armstrong Farm in what had been a continuous corn production system where acid soil had developed from nitrogen (N) fertilizer use. In 2003, the experimental area was divided into thirds. A corn-soybean rotation occupies two-thirds of the area and continuous corn continues to occupy the remaining third. The goals of this experiment are to determine corn crop and soil responses to liming and crop rotation effects on N management.

Material and Methods

In 1994, soil pHs were in the fours in the 0 to 6-in. depth. As determined by the SMP buffer pH test, the lime requirement to raise soil pH to 6.5 was 15,000 lb/acre of effective calcium carbonate equivalent (ECCE). Fifteen tons/acre of ag lime from the Atlantic quarry supplied this need. 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 pHs of 5.5, 6.0, 6.5, and 7.0, respectively. In June of 2004, soil samples for analysis of soil nitrate (NO_3)-N and other soil testing parameters were collected when corn plants were 10 in. tall. The NO_3-N test results were used to determine N-credits from the previous soybean crop.

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 six inches above the soil, were collected. The shelled grain was analyzed at the ISU Grain Quality Laboratory, which is supported by the Iowa Grain Quality Initiative. Cornstalk samples will be analyzed for NO_3-N contents at a later date.

Results and Discussion

Soil test acidity (pH); ammonium (NH_4-N), NO_3-N, phosphorous (P), potassium (K) responses to lime, and crop rotation are shown in Table 1. Ag lime neutralized soil acidity is noted by soil pH; the greatest pH change occurred from the 45-ton lime rate. Soil test P increased significantly when soil pHs were greater than 6.5. Both NH_4-N and NO_3-N were slightly greater in the most acid soil. Soybean residue increased NO_3-N levels resulting in a 20-lb/acre N-credit. Based on the Late-spring NO_3-N test results, 150 and 130 lb/acre were applied to the continuous corn and corn grown after soybean plots, respectively.

Grain yields and quality data are presented in Table 2. Over 220 bushels/acre of corn were measured from all treatments. Yield variability was greatest in continuous corn plots because of volunteer corn. Grain protein content was greatest at the highest soil pH levels. Even slight protein increases are important for the producer who feeds corn to livestock. Table 3 shows the effects of liming rate on soil cation contents. When limestone is added to acid soil, it reacts to neutralize acidity and dissolves calcium (Ca) and then replaces hydrogen (H) on the soil exchange complex. Depending upon the source of limestone, the ratio of Ca to magnesium (Mg) can be markedly altered. Dolomite limestone sources can possess large amounts of Mg and thus reduce Ca absorption. In this experiment, soil Mg contents remained nearly constant and the ratio of Ca to Mg increased with liming rate.

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Table 1. Late-spring nitrate-nitrogen and other soil test values measured in 2004.

Lime rate	Acidity	SMP buffer	NH_4-N	NO_3-N	P	K
(tons per acre)	--------- pH --------		---------- ppm ----------			
Continuous corn						
0	5.4	6.4	3.2	5.5	28	322
1.7	5.8	6.6	2.9	5.4	25	297
5	6.3	6.8	2.4	3.0	27	276
15	6.7	7.0	2.8	5.6	40	289
45	7.0	7.2	2.5	4.0	37	246
Corn-soybean rotation						
0	5.4	6.3	3.2	8.0	30	223
1.7	5.7	6.6	2.5	6.0	31	258
5	6.0	6.7	2.7	5.6	29	201
15	6.7	7.1	3.0	6.9	38	241
45	7.2	7.3	2.6	7.9	39	198

Table 2. Corn harvest and grain quality responses in 2004.

	Harvest		Grain quality analysis		
Lime rate	Moisture	Yield	Protein	Oil	Starch
(tons per acre)	(percent)	(bushels/acre)	---------- percent ----------		
Continuous corn					
0	19.4	228	6.8	3.7	61.5
1.7	19.3	230	6.9	3.7	61.6
5	19.8	220	7.0	3.7	61.5
15	19.6	227	7.0	3.6	61.6
45	19.8	231	7.0	3.8	61.5
Corn-soybeans					
0	19.4	231	6.8	3.7	61.6
1.7	19.1	234	6.9	3.7	61.6
5	19.4	232	6.8	3.5	61.8
15	19.4	232	7.0	3.7	61.4
45	19.1	230	7.0	3.7	61.5

Table 3. Soil cation responses to limestone treatments measured in 2004.

	Basic cations and H contents					
Lime rate	K	Ca	Mg	Na	H	Ca:Mg
(tons per acre)	---------- milliequivalents per 100 grams of soil ----------					(ratio)
Continuous corn						
0	0.8	5.8	2.9	0.5	7.5	2.04
1.7	0.8	6.3	2.8	0.5	5.1	2.26
5	0.7	7.1	2.8	0.5	2.1	2.59
15	0.7	8.4	2.6	0.5	2.4	3.23
45	0.6	8.9	2.3	0.4	0.0	3.91
Corn -soybean rotation						
0	0.6	6.1	3.4	0.6	7.8	1.82
1.7	0.7	6.5	3.1	0.5	5.1	2.12
5	0.5	7.3	3.1	0.4	3.1	2.38
15	0.6	8.2	2.9	0.4	0.0	2.90
45	0.5	10.1	2.8	0.4	0.0	3.65