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Limestone Sources and Crop and Soil Responses

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Abstract
Southeast Iowa producers have expressed interest in limestone source effects on crops and soils. Quarried, crushed limestone is the most common liming material used to neutralize soil acidity. Depending upon the quarry, limestone may be calcitic, dominated by calcium (Ca) carbonate, or dolomitic, possessing varying portions of Ca and magnesium (Mg) carbonate. Without exposure to soil acidity, very little limestone dissolves in the soil. But, when limestone is exposed to acidity, it dissolves and either Ca or Mg ions replace hydrogen (H) ions on the soil exchange complex. Among all the ions adsorbed on the soil exchange complex, there exists a chemical equilibrium between the soil solution and this complex. This not only affects the balance of nutrients absorbed by plant roots but the stability of the soil as well. This experiment examines the effects of calcitic and dolomitic limestone sources and their rates of application on crops and soils.

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Introduction

Southeast Iowa producers have expressed interest in limestone source effects on crops and soils. Quarried, crushed limestone is the most common liming material used to neutralize soil acidity. Depending upon the quarry, limestone may be calcitic, dominated by calcium (Ca) carbonate, or dolomitic, possessing varying portions of Ca and magnesium (Mg) carbonate. Without exposure to soil acidity, very little limestone dissolves in the soil. But, when limestone is exposed to acidity, it dissolves and either Ca or Mg ions replace hydrogen (H) ions on the soil exchange complex. Among all the ions adsorbed on the soil exchange complex, there exists a chemical equilibrium between the soil solution and this complex. This not only affects the balance of nutrients absorbed by plant roots but the stability of the soil as well. This experiment examines the effects of calcitic and dolomitic limestone sources and their rates of application on crops and soils.

Materials and Methods

Soil samples from the experimental area were collected in 1989 and determined to be acidic; pHs ranged from 5.5–6.0. Plots were laid out 20 ft wide and 45 ft long. Liming treatments were selected that included no application or check; 1,000, 2,000, 4,000, and 6,000 lb/acre of dolomitic limestone; and 1,000 and 2,000 lb/acre of calcitic limestone. The effective calcium carbonate (ECCE) of the materials used for treatments was approximately 1,050 lb/ton. The liming treatments were applied in the summer of 1989. Potash fertilizer is applied at 60 lb of potassium (K) per acre before each corn crop is grown. Phosphorus (P) fertilizer is applied according to soil-test results as needed before each corn crop is grown. The farm superintendent selects corn and soybean cultivars and applies herbicides. Nitrogen is applied at a rate of 100 lb/acre. A 5-ft-wide alleyway is cut each year to delineate plots and three rows of corn and five rows of soybeans, 40 ft long, are combine harvested from each plot. Yields are calculated and adjusted to a standard moisture content.

Results and Discussion

Soil sampling is undertaken each year from the soybean plots after harvest. Soil-test results for 2003 and 2004 are shown in Table 1. Soil acidity has increased since last reported in 1999 when maximum pHs were achieved. To accurately evaluate residual effects of either limestone source on soil Ca and Mg, reliming has not been undertaken. Soil Ca and Mg contents were evaluated using one normal ammonium acetate extraction. The amount of each element is reported as milliequivalents (meq) per 100 grams of soil. Dividing Ca by Mg content yields a quotient that is the ratio of these elements. Soil testing indicated that increasing rates of dolomitic limestone increased soil Mg content. Calcium contents in 2003 were nearly constant among treatments but variable among treatments sampled in 2004. Although the areas sampled each year are different, they are adjacent in the field. Reducing Ca:Mg ratios reflect the soil's gain in Mg from the dolomitic limestone source. Table 2 gives corn and soybean yield data for the past five years. Analysis of these data with Ca:Mg ratios shows random if any correlation. Owing to the fact that Ca and Mg are abundant in the soil, no soil fertility response was expected from either limestone source. However, soil Ca:Mg ratios are of importance to manage soil stability and the soil's internal drainage. This experiment was not designed to evaluate those factors that will interact with environmental conditions such as excessive precipitation.

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Table 1. Limestone source and rate experiment soil-test values.

Source	Limestone	pH	P	K	Ca	Mg	Ca:Mg
	lb/acre		ppm		meq/100g		ratio
Sampled in 2003							
Check	0	5.80	24.6	146	17.4	4.57	3.87
Dolomitic	1000	5.87	22.3	142	17.5	4.88	3.69
Dolomitic	2000	5.91	23.7	146	17.3	4.70	3.80
Dolomitic	4000	6.05	21.0	162	17.7	5.16	3.47
Dolomitic	6000	5.99	21.0	139	17.4	5.14	3.45
Calcitic	1000	5.97	17.9	142	17.7	5.07	3.57
Calcitic	2000	5.94	18.5	164	17.2	4.85	3.61
Sampled in 2004							
Check	0	5.59	13.1	143	16.3	4.59	3.55
Dolomitic	1000	5.59	15.9	140	16.6	4.73	3.54
Dolomitic	2000	5.74	15.4	155	17.8	5.38	3.33
Dolomitic	4000	5.82	16.0	167	18.2	5.68	3.21
Dolomitic	6000	5.86	14.5	153	18.2	5.83	3.12
Calcitic	1000	5.73	14.1	159	16.8	4.59	3.67
Calcitic	2000	5.56	18.7	152	17.4	4.59	3.80

Table 2. Limestone source and rate experiment corn and soybean yields.

Source	Limestone	2004	2003	2002	2001	2000	Avg
Corn	lb/acre			bushels/acre			
Check	0	225	167	175	173	181	184
Dolomitic	1000	202	184	168	174	163	178
Dolomitic	2000	213	174	174	168	181	182
Dolomitic	4000	200	167	184	171	168	178
Dolomitic	6000	224	171	179	164	173	182
Calcitic	1000	218	175	178	172	168	182
Calcitic	2000	217	175	188	161	174	183
Soybeans							
Check	0	62.9	45.4	55.3	56.4	50.4	54.1
Dolomitic	1000	67.0	46.8	55.0	57.1	50.9	55.4
Dolomitic	2000	63.0	45.5	59.4	55.1	50.3	54.7
Dolomitic	4000	64.4	46.8	58.1	57.9	52.0	55.8
Dolomitic	6000	67.6	47.4	57.8	58.8	49.4	56.2
Calcitic	1000	64.8	46.8	57.0	59.6	51.9	56.0
Calcitic	2000	68.0	47.3	57.2	56.8	53.3	56.5