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Crop and Soil Responses to Lime Sources and Potassium

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Abstract

Producers in southeast Iowa have expressed interest in lime sources effects on crops and soils. Quarried, crushed limestone is the most common liming material used to neutralize soil acidity. Depending upon the quarry, the limestone may be calcitic or dolomitic. Calcite limestone is composed of calcium (Ca) carbonate, and dolomite is composed of calcium and magnesium (CaMg) carbonate. When either material is applied to soil, it will react to soil acidity, and Ca or CaMg will replace hydrogen ions on the soil exchange complex. Only a very small amount will dissolve in the soil solution without reacting to soil acidity. The Ca and Mg ions displace acidic hydrogen (H) ions and are in equilibrium with other positively charged ions (cations) in the soil solution. Thus, a chemical equilibrium develops among all the cations that affects the balance of nutrients absorbed by plant roots. This experiment examines the effects of liming source and potassium (K) fertilizer, and their rates of application on crops and soils.

Keywords

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Disciplines

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Introduction

Producers in southeast Iowa have expressed interest in lime sources effects on crops and soils. Quarried, crushed limestone is the most common liming material used to neutralize soil acidity. Depending upon the quarry, the limestone may be calcitic or dolomitic. Calcite limestone is composed of calcium (Ca) carbonate, and dolomite is composed of calcium and magnesium (CaMg) carbonate. When either material is applied to soil, it will react to soil acidity, and Ca or CaMg will replace hydrogen ions on the soil exchange complex. Only a very small amount will dissolve in the soil solution without reacting to soil acidity. The Ca and Mg ions displace acidic hydrogen (H) ions and are in equilibrium with other positively charged ions (cations) in the soil solution. Thus, a chemical equilibrium develops among all the cations that affects the balance of nutrients absorbed by plant roots. This experiment examines the effects of liming source and potassium (K) fertilizer, and their rates of application on crops and soils.

Material and Methods

In 1989, soil samples from the experimental area were collected and determined to be acidic, with pHs ranging from 5.5 to 6.0. Plots 20 feet wide × 45 feet long were laid out. Eight liming treatments designed: no application—check plot; 1000, 2000, 4000, 6000 lbs/acre CaMg–limestone; 1000 and 2000 lbs/acre Ca–limestone and 185 lbs very fine limestone/100 lbs of nitrogen fertilizer used when corn was grown. The effective calcium carbonate (ECCE) of the materials used for treatments 2–7 was approximately 1,050 lbs/ton. The liming treatments were applied in the summer of 1989 except for the treatment of limestone/nitrogen fertilizer, which was applied when corn was grown. Since then, K–fertilizer is applied at 0, 60 and 120 lbs K/acre before each corn crop is grown. The effective K–rates are 0/30/60 lbs/acre/yr. No K–fertilizer is applied before planting soybeans. The farm superintendent selects corn and soybean cultivars and applies herbicides. Nitrogen is applied at a rate of 100 lbs/acre except in 2001, when the plots were split and 100/150 lbs were applied. A five-foot-wide alley delineates plots. Three rows of corn and five rows of soybeans, each 40-feet long, are harvested, with yields recorded.

Results and Discussion

A detailed sampling of soil in all the plots was undertaken in 1994. From 1995 to 2001, soil samples were collected only from those plots where soybeans had grown each year (except 1998). The effects of liming on soil acidity are shown in Table 1. Maximum soil pHs were reached in 1997 and 1999. The greatest pHs, or neutralization of acidity, were achieved with the greatest rates of liming material applied. The pH values from the 1000 and 2000 lbs/acre treatments of Ca– or CaMg–limestone were equal. The Ca–limestone sources affected the Ca– and Mg–saturation of the soil cation exchange complex. Mg-saturation decreased 10% where the Ca sources were applied and remained nearly constant where CaMg–limestone was used. Greater K-application rates increase the amount of plant-available K. However, the check plot where no K is applied, suggests the need for only a small amount of this fertilizer nutrient. Corn and soybean yields were slightly increased by liming and K-fertilizer treatments (Table 2).

This experiment showed that limestone sources can affect Ca- and Mg-saturation of the cation exchange complex of soil. Because the local quarry supplies CaMg–limestone and it was historically applied on the farm, soil composition of the field reflects its Ca- and Mg-contents. Changing to a Ca–limestone treatment decreased Mg-saturation significantly—from 1000, 2000 lbs/acre to 185 lbs/100 lbs N/acre application.

Acknowledgments

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Table 1. Soil reaction to liming treatments.

Lime source and rate	1994	1995	1996	1997	1999	2000	2001	Avg.
None	5.3	5.8	5.5	5.8	5.6	5.6	5.6	5.6
$CaMg_{1000}$	5.4	5.8	5.8	5.9	5.7	5.8	5.7	5.7
$CaMg_{2000}$	5.6	5.9	5.7	6.0	5.8	5.9	5.7	5.8
$CaMg_{4000}$	5.5	6.0	5.9	6.0	6.0	6.1	5.8	5.9
$CaMg_{6000}$	5.7	6.1	6.1	6.3	6.1	6.1	6.0	6.0
Ca_{1000}	5.3	5.9	5.7	5.9	5.7	5.7	5.6	5.6
Ca_{2000}	5.5	6.0	5.8	6.0	5.8	5.6	5.7	5.7
Ca_{fine}	5.3	5.8	5.7	5.8	5.7	5.8	5.6	5.6
Average	5.4	5.9	5.7	5.9	5.8	5.8	5.7	5.7

Table 2. Summary of SERF Lime K corn data from 1996 to 2001.

Lime source and rate	1996	1997	1998	1999	2000	2001	Avg.
			Corn yields, bushels/acre				
None	143	145	--	147	181	173	158
$CaMg_{1000}$	140	156	--	145	163	177	156
$CaMg_{2000}$	143	156	--	151	181	167	159
$CaMg_{4000}$	144	151	--	147	168	175	157
$CaMg_{6000}$	145	166	--	146	173	165	159
Ca_{1000}	140	158	--	146	168	179	158
Ca_{2000}	142	158	--	152	174	167	158
Ca_{fine}	138	158	--	142	178	160	155
Average	142	156	--	147	173	170	158
			Soybean yields, bushels/acre				
None	42.2	42.1	42.1	52.4	49.9	56.4	47.5
$CaMg_{1000}$	43.2	45.1	45.9	54.5	50.4	57.1	49.4
$CaMg_{2000}$	47.2	45.0	42.8	54.5	49.1	55.1	49.0
$CaMg_{4000}$	45.9	43.9	48.1	54.4	52.8	57.9	50.5
$CaMg_{6000}$	44.7	46.7	47.0	53.7	49.6	58.8	50.0
Ca_{1000}	43.9	43.5	48.4	54.6	50.8	59.6	50.1
Ca_{2000}	46.1	44.3	44.9	54.8	51.9	56.8	49.8
Ca_{fine}	42.7	41.7	42.8	53.2	50.2	56.3	47.8
Average	44.5	44.0	45.2	54.0	50.6	57.2	49.3