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Soil pH Change as Affected by the Lime Source and Application Rates

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Abstract
Agricultural limestone is commonly used in Iowa to maintain optimum soil pH for crops. There is insufficient information, however, concerning the reaction time of lime sources in the soil and short-term effects on crop yield for different sources and application rates. This information is needed to improve soil pH management and lime recommendations. The objective of this study was to study the soil pH and crop response to the application of pure calcium carbonate (CaCO3), and calcitic or dolomitic limestones in a typical acidic soil of southwest Iowa.

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Soil pH Change as Affected by the Lime Source and Application Rates

RFR-A1095

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Introduction

Agricultural limestone is commonly used in Iowa to maintain optimum soil pH for crops. There is insufficient information, however, concerning the reaction time of lime sources in the soil and short-term effects on crop yield for different sources and application rates. This information is needed to improve soil pH management and lime recommendations. The objective of this study was to study the soil pH and crop response to the application of pure calcium carbonate ($CaCO_3$), and calcitic or dolomitic limestones in a typical acidic soil of southwest Iowa.

Materials and Methods

The experiment was established in 2009 at the Armstrong Research and Demonstration Farm on an area with Marshall silty clay loam soil. Initial soil-test values were pH 5.5, SMP buffer pH 6.5, organic mater 3.9 percent, and optimum to high P and K levels. Fifteen treatments replicated three times were the combinations of three lime sources and five application rates. The lime sources were pure and finely ground calcium carbonate ($CaCO_3$), calcitic limestone (41% calcium and 0.2% magnesium), and dolomitic limestone (20% calcium and 8% magnesium). The calcium carbonate equivalent (CCE) concentrations were 99, 89, and 69 percent, respectively. The application rates were based on the CCE of each source, and were 0, 2, 4, 6, and 10 ton CCE/acre. The Effective CCE (ECCE, which also considers fineness) was 98, 54, and 39 percent, respectively. The highest ECCE rates applied were 9.8, 5.4, and 3.9 ton/acre for the calcium carbonate and the calcitic and dolomitic limestone. The amendments were applied on April 2, and were incorporated into the soil by disking. Soybean was planted in 2009. Soil samples were collected from a 6-in. depth before applying lime and six times until spring 2010 (on March 29). No-till corn was planted after the last soil sampling date to evaluate grain yield for a second year.

Results and Discussion

The soil pH increase over time due to lime application was curvilinear with decreasing increments to a maximum plateau for all lime sources and application rates. The maximum plateau pH level varied across lime sources and rates, but was reached about 150 days after liming or sooner (Figure 1). The early pH increases and the maximum pH reached were greater for the pure calcium carbonate than for either limestone. We did not expect such a fast reaction of limestone with soil, but plateau maxima observed for the three sources suggest that no further pH increase would occur.

The CCE application rate needed to maximize soil pH was lowest for the calcium carbonate, intermediate for calcitic limestone, and highest for dolomitic limestone (Figure 2). Because the rates were based on similar amounts of CCE for all sources, we believe that a finer particle size likely explains a higher maximum acid-neutralizing effect for the the finely ground, pure calcium carbonate. The lowest maximum pH reached with the dolomitic limestone compared with the calcitic limestone was explained by its coarser particle size. A possible slower reaction of the dolomitic limestone due to possible slower reaction of magnesium carbonate ($MgCO_3$) was not clearly observed in this study.

There were no corn or soybean grain yield increases from application of any lime source (data not shown). Other studies conducted at this farm during several years have shown significant yield increases from lime application to more acidic soil.

Conclusions

The different lime sources determined distinct rates of soil pH increase until about 150 days after application. The maximum plateau pH reached was lower for limestone than for pure $CaCO_3$, presumably due to a coarser particle size (lower ECCE).

Acknowledgements

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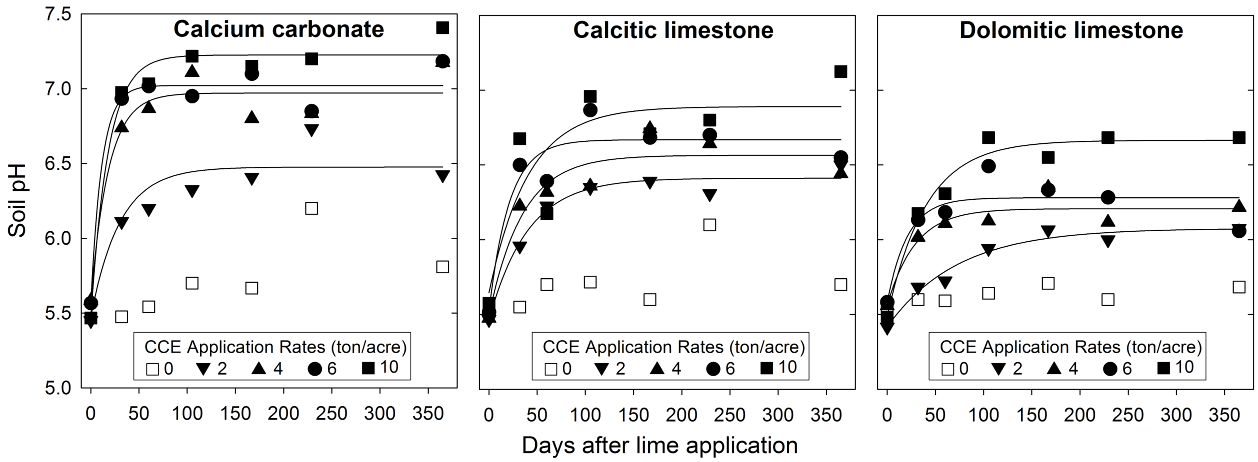

Figure 1. Soil pH trends over time as affected by three lime sources and the calcium carbonate equivalent (CCE) application rate.

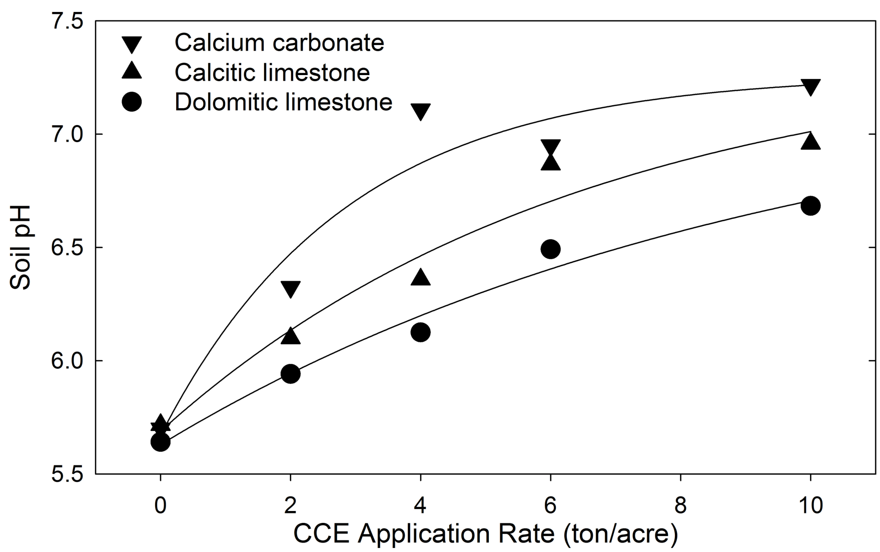

Figure 2. Soil pH as affected by three lime sources and the calcium carbonate equivalent (CCE) application rate for the sampling date about 100 days after liming (when the maximum pH was reached for most sources and rates).