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Change of Soil pH over Time as Affected by Lime Sources and Application Rates

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Abstract
Agricultural limestone is commonly used in Iowa to maintain optimum soil pH for crops. However, there is insufficient information 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 limestone in a typical acid soil of northeast Iowa.

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Change of Soil pH over Time as Affected by Lime Sources and Application Rates

RFR-A10108

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Introduction

Agricultural limestone is commonly used in Iowa to maintain optimum soil pH for crops. However, there is insufficient information 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 limestone in a typical acid soil of northeast Iowa.

Materials and Methods

An experiment was established in 2009 at the Northeast Research and Demonstration Farm on an area with Kenyon loam soil. The initial soil pH was 5.4, SMP buffer pH was 6.7, and organic matter was 2.8 percent. 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 3, and were incorporated into the soil by disking. Soybeans were planted in 2009. Soil samples were collected from a 6-in. depth before applying lime and seven times until September 16, 2010. 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). We did not expect a pH change for the control plots over time. We were careful to avoid any contamination of the plots. Perhaps the soil acid initial pH of 5.4 (average of several samples) was a temporal natural variation. The early pH increase 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 lower maximum soil 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 statistically significant corn or soybean grain yield increases from application of any lime source. This result gives support for a temporal variation for the very acid initial pH, because pH for the control plots was higher (5.6 to 5.8) for most other sampling dates.

Conclusions

The different lime sources determined different 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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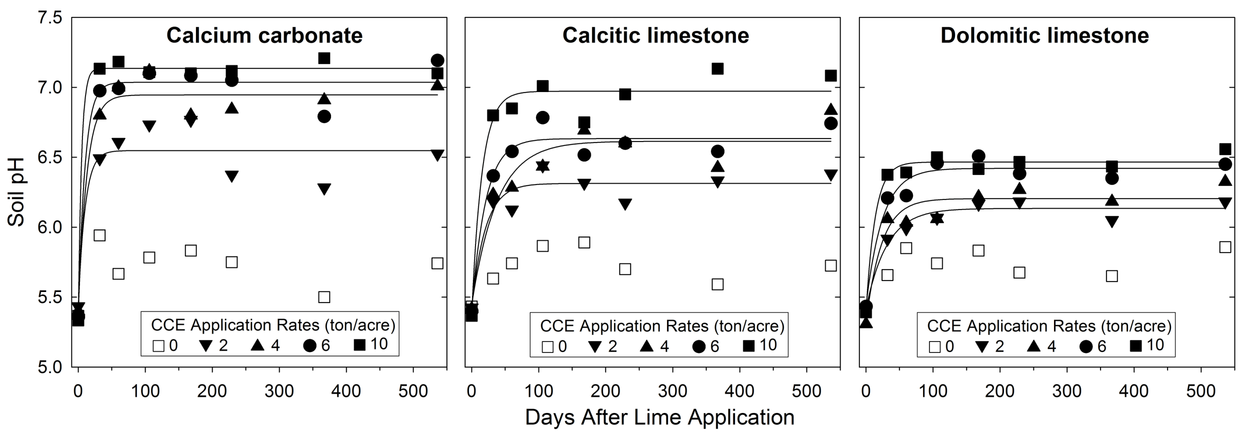

Figure 1. Soil pH trends over time as affected by three lime sources and the calcium carbonate equivalent (CCE) application rate.

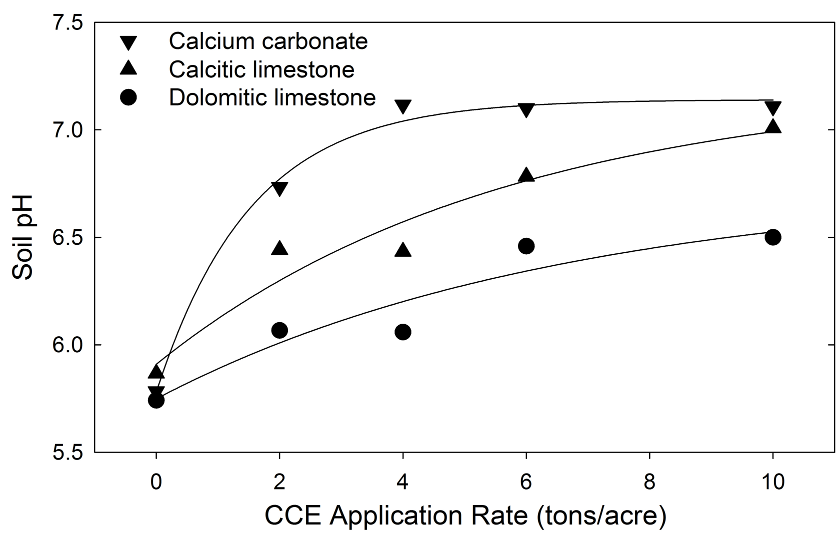

Figure 2. Soil pH as affected by three lime sources and the calcium carbonate equivalent (CCE) application rate for the sampling date about 100 days after liming (when the maximum pH was reached for most treatments).