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

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Abstract
Agricultural limestone is commonly applied to maintain optimum soil pH for crops. There is insufficient information, however, about short-term effects of different lime sources and application rates on soil pH changes over time and crop yield. This information is needed to improve soil pH and lime management. The objective of this experiment was to study the soil pH and crop yield response to application of pure calcium carbonate, calcitic limestone, and dolomitic limestone.

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RFR-A1056

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Introduction

Agricultural limestone is commonly applied to maintain optimum soil pH for crops. There is insufficient information, however, about short-term effects of different lime sources and application rates on soil pH changes over time and crop yield. This information is needed to improve soil pH and lime management. The objective of this experiment was to study the soil pH and crop yield response to application of pure calcium carbonate, calcitic limestone, and dolomitic limestone.

Materials and Methods

The experiment was established in 2009 at the Northwest Research and Demonstration Farm. The soil type at the site was Galva silty clay loam. Initial soil-test values were pH 5.5, SMP buffer pH 6.3, organic mater 5.0 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 (which also considers fineness) was 98, 54, and 39 percent ECCE, respectively. The highest ECCE rates applied were 9.8, 5.4, and 3.9 ton/acre for the calcium carbonate, calcitic limestone, and dolomitic limestone, respectively.

The amendments were applied on April 11 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 30). No-till corn was fertilized and planted after the last soil sampling date to evaluate grain yield for a second year.

Results and Discussion

The soil pH increase over time for the three lime sources and all application rates was curvilinear with decreasing increments to a maximum plateau pH value. The maximum plateau pH level varied across lime sources and rates, but was reached about 100 days after liming or sooner (Figure 1). The early pH increases and the maximum pH reached were greater for pure calcium carbonate than for either limestone. We did not expect such a fast reaction of limestone with the soil, but obvious plateau maxima observed for the three sources indicated 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, a coarser particle size likely explains a lower maximum acid-neutralizing effect for limestone than for finely ground calcium carbonate. The smallest effect of the dolomitic limestone was explained by its coarser particle size. A possible slower reaction of the dolomitic limestone due to slower reaction of magnesium carbonate ($MgCO_3$) compared with calcium carbonate was not clearly observed in this study.

There were no statistically significant yield increases for corn or soybean from application of any lime source (not shown). Other experiments conducted at this farm over several years have shown significant yield increases from lime application to more acidic soil (pH 5.2 to 5.4).

Conclusions

The lime sources determined different rates of soil pH increase to maximum pH values reached about 100 days after application or sooner. The maximum plateau pH reached was lower for the limestone sources than for pure, finely ground calcium carbonate presumably due to a coarser particle size (lower ECCE).

Acknowledgements

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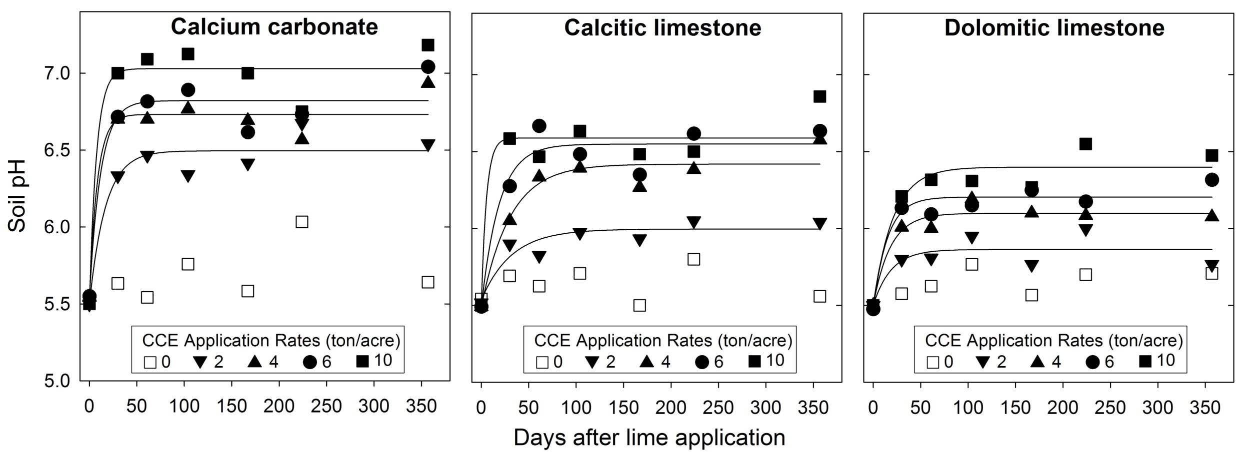

Figure 1. Soil pH as a function of time for three lime sources and calcium carbonate equivalent (CCE) application rates.

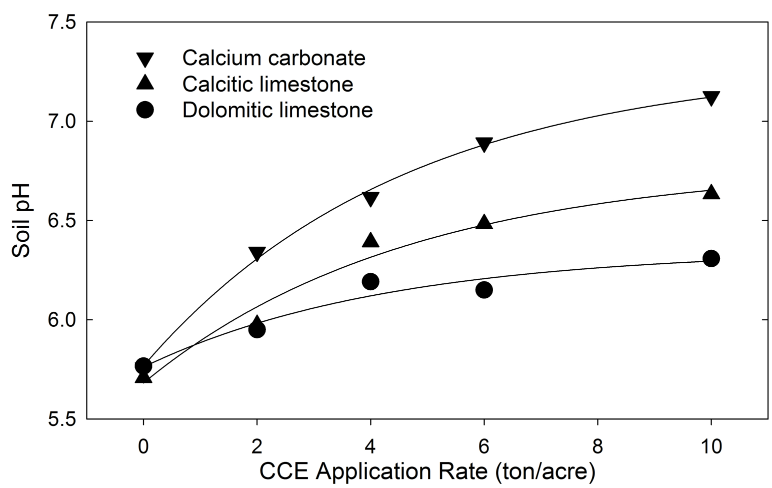

Figure 2. Soil pH as affected by the lime source and the calcium carbonate equivalent (CCE) application rate for the sampling date about 100 days after liming (when the maximum pH was reached for the slowest reacting source).