Evaluation of the Efficiency of Aglime and Pelleted Aglime in an Iowa Sandy Soil

RFR-A1623

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Introduction

The effectiveness of a liming material for neutralizing soil acidity depends mainly on its calcium carbonate ($CaCO_3$) equivalent (CCE) and its fineness. The Iowa Department of Agriculture and Land Stewardship (IDALS) rules for agricultural lime (aglime) sales requires measuring Effective CCE (ECCE), which combines CCE and fineness efficiency estimates. Use of pelleted finely ground limestone has increased in recent years, but scarce field research has evaluated how ECCE evaluates the granulation effect on its acid-neutralizing capacity and its efficiency compared with aglime. Therefore, a study was conducted at this farm during 2015 and 2016 to compare the effectiveness of finely ground pure calcium carbonate ($CaCO_3$), calcitic aglime, and pelleted calcitic aglime at increasing soil pH and crop yield.

Materials and Methods

A two-year trial was conducted on a Fruitland sandy soil. Soil pH, organic matter, calcium (Ca), magnesium (Mg), and sodium (Na) were 6.1, 1.3 percent, 541 ppm, 86 ppm, and 15 ppm, respectively. Uniform and non-limiting rates of phosphorus, potassium, sulfur, and micronutrients fertilizers were applied. Treatments replicated three times were commercial sources of finely ground calcium carbonate, calcitic aglime, and pelleted calcitic aglime applied at four rates plus a non-limed control. The CCE and ECCE of the lime sources were analyzed as required by IDALS (Table 1). The lime sources were applied at rates of 0, 1, 2, 4, and 8 ton CCE/acre to plots 7.5 by 12 ft. As lime sources analyses indicate, the CCE was similar for all three sources but ECCE was lower for the aglime. The treatments were broadcast October 24, 2014, and were incorporated by light disking November 3 after light irrigation. The plots were disked again just before planting corn (Pioneer 1324 HR) April 28, 2015. The cornstalks were lightly disked October 28, and soybean (Pioneer 31T11R) was no-till planted in spring 2016. Soil samples (6-in. depth) to measure pH were taken in March, June, October, and December 2015 and in March and September 2016. Grain was harvested from a central area of each plot and yield was adjusted to 15.5 percent moisture for corn and 13 percent moisture for soybean.

Results and Discussion

Crop yield response. Liming with any of the three sources did not result in statistically significant yield increases in any year of the study (Table 2). However, there was a responsive trend for corn that should not be ignored, because yield of the unlimed control was lower by about 10 bushels/acre. High variability precluded statistical significance. Soybean planted the second year showed no statistical response, and on average the yield of the control was about two bushels lower than for the lime treatments. Therefore, the lowest CCE rate of 1 ton/acre (0.61 to 0.99 ton ECCE) maximized yield and there was no difference between liming sources. The small yield response in this soil with pH 6.1 is not surprising. Other research has shown the optimum pH for corn and soybean ranges from 6.0 to 6.5 for different soils and regions. Currently, the liming guidelines in ISU extension publication PM 1688 suggest liming eastern Iowa soils with pH lower than 6.5. *Soil pH increases from liming*. Figure 1 shows the largest pH increase was observed 4.5 months after the application of the materials (first sampling date). Further increases were smaller until a plateau pH was reached with most sources and application rates between 12 and 17 months after application, and a decrease was observed for all treatments by the last sampling date 23 months after the application. It must be noted that, due to unknown reasons, the control unlimed plots also showed a very large pH decrease after the 14-month sampling date, which was proportionally larger than the decrease observed for the limed treatments. This pH decrease for all treatments in fall 2016 probably was a seasonal effect, and perhaps pH would have increased somewhat later.

Figure 2 summarizes soil pH responses to lime application for the earliest sampling date (4.5 months) and the average of the three latest sampling dates, when a high plateau was observed (12 to 17 months). For each period, graphs show the pH responses by expressing the application rates as amounts of CCE/acre or ECCE/acre. The lime sources analyses in Table 1 and the graphs show the unit used to express the application rate didn't make much difference for pelleted lime because its ECCE was very high and about the same as calcium carbonate. However, the ECCE application rates were much smaller for aglime, because, as is commonly the case, its ECCE was lower.

Graphs A and B in Fig. 2 have application rates expressed as CCE/acre and show little or no difference between calcium carbonate and pelleted lime for either time period. The pH increase was smaller for aglime, but the difference with the other two sources became much smaller over time, which indicates a slower reaction time for aglime. Graphs C and D in Fig. 2 have application rates expressed as ECCE/acre and show much smaller differences between aglime and the other two sources no matter the sampling date. The response curve for aglime was still lower than for the other sources, mainly for the higher application rates. These results indicate the ECCE measurement slightly over-estimated the acid neutralizing capacity of aglime, even for the latest sampling dates when large amounts were applied. However, the over-estimation and pH difference was very small, and perhaps would have been smaller had we continued sampling for a longer period of time.

Conclusions

Pelleted lime and pure powdered calcium carbonate increased soil pH similarly, and faster than aglime. The effectiveness of aglime increased over time, but even by the later sampling dates ECCE over-estimated its efficiency slightly. The ECCE method correctly assessed the pelleted lime neutralizing value. In spite of lower early pH increases by applying aglime, all three lime sources were similar at increasing crop yield in both years of the study.

Acknowledgements

We recognize partial funding by Calcium Products, Inc. and in-kind support by Martin-Marietta, Inc.

Table 1. Characteristics of three liming materials used in the study.

						Pass through of screen sizes		
Lime source	**Moisture**	**CCE†**	**ECCE ‡**	**Ca**	**Mg**	**4**	**8**	**60**
	---------------------------- % --------------------------							
$CaCO_3$	0.07	92.5	92.0	37.1	0.1	100	100	100
Aglime	6.50	91.4	56.2	36.8	0.2	100	99	37
Pelleted lime	0.45	90.1	88.6	36.8	0.2	100	100	97

† CCE, $CaCO_3$ equivalent. ‡ ECCE, effective CCE calculated as required by IDALS.

Table 2. Effect of lime source and application rate on crop yield.

	Application rate		Crop yield	
Source	**CCE**	**ECCE**	**Corn**	**Soybean**
	---- ton/acre ----		------- bu/acre -------	
Control	0	0	179	74.5
Aglime	1	0.61	189	77.6
	2	1.23	191	78.2
	4	2.46	188	77.8
	8	4.92	188	77.1
Calcium carbonate	1	0.99	188	72.8
	2	1.99	189	77.9
	4	3.98	188	75.4
	8	7.96	192	78.6
Pelleted lime	1	0.98	189	75.0
	2	1.97	192	79.6
	4	3.93	189	72.6
	8	7.87	191	76.7

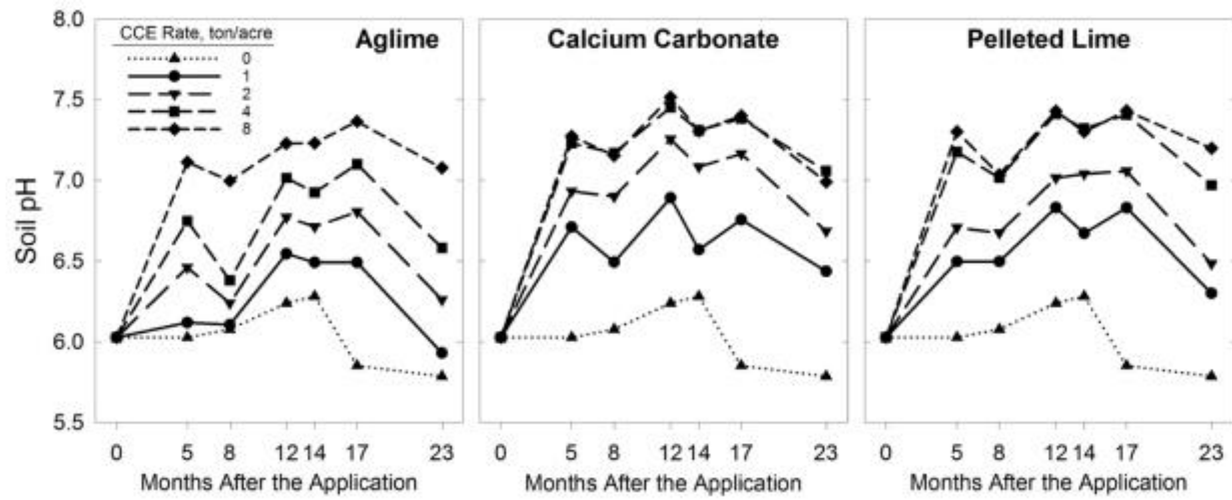

Figure 1. Effect of several calcium carbonate equivalent (CCE) application rates with three lime sources on soil pH over a 23-month period.

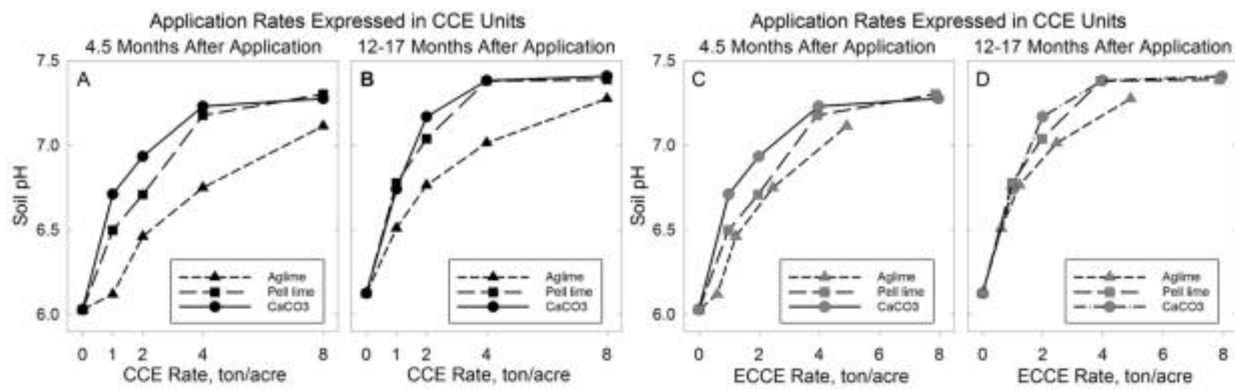

Figure 2. Soil pH at two times after applying three lime sources with the rates expressed as CCE or ECCE.