VIRGINIA

Short-term Soil Chemical and Crop Yield Responses to Aglime Applications

By M.M. Alley

Crop yields are reduced on acid soils due to toxic concentrations of aluminum (Al) and, in some soils, manganese (Mn). The availability of applied and residual soil phosphorus (P) in mineral soils is maximized when soil pH levels are between 6.0 and 6.5, as is the retention and availability of applied potassium (K).

For legume crops, the nitrogen (N) fixing capacity of Rhizobia bacteria is maximized at pH levels between 6.0 and 7.0. Rhizobia need high levels of available calcium (Ca) and magnesium (Mg), as well as adequate supplies of molybdenum (Mo), the only micronutrient that increases in availability as soil pH increases. Moreover, other soil organisms that decompose organic matter and contribute to the general health of soils are most active at soil pH levels of 6.0 to 7.0. Finally, many herbicides lose effectiveness as soils become acid.

Recommendations for aglime use generally call for application at least 2 to 6 months prior to planting due to the slow rate of soil-lime reaction. Virginia studies show that soil chemical properties change rapidly and that crop yields increase with aglime applications made immediately prior to planting on acid soils.

Recommendations for aglime use generally call for an application at least 2 to 6 months prior to planting due to the supposedly slow rate of soil-limestone reaction. In practice, much aglime is applied immediately prior to planting because of soil and crop conditions, or the application is delayed because of the belief that

TABLE 1. Liming affects soil pH, exchangeable soil Ca and Mg. It also decreases exchangeable Al and lowers Al saturation of the soil's exchange complex.

	Goldsboro sandy loam Exchangeable					Pacolet sandy clay loam Exchangeable				
Lime rate, tons/A	pH	Ca	Mg	Al	Al sat.[1], %	pH	Ca	Mg	Al	Al sat.[1], %
		meq/100 g					meq/100 g			
0.0	4.1	0.21	0.08	1.66	76	5.3	1.94	0.89	0.27	8
0.5	4.6	0.38	0.24	1.15	56	–	–	–	–	–
1.0	4.6	0.53	0.40	0.56	33	5.9	2.06	1.01	0.04	1
2.0	5.0	0.74	0.54	0.32	18	5.9	2.30	1.12	0.02	1
3.0	–	–	–	–	–	6.2	2.40	1.19	0.02	1
4.0	5.2	1.01	0.78	0.04	2	6.2	2.40	1.20	<0.01	<1
6.0	5.5	1.20	0.95	0.02	1	6.5	2.80	1.33	<0.01	<1
8.0	–	–	–	–	–	6.4	2.80	1.40	<0.01	<1

Sampled 16 weeks after liming. Virginia

[1]Percent Al saturation = $\frac{\text{Exchangeable Al}}{\text{Exch. Ca + Exch. Mg + Exch. K + Exch. Al}} \times 100$

little benefit will be obtained by the initial crop. This article reports on studies that were conducted to quantify initial crop yield benefits as well as soil chemical changes that occur soon after aglime applications.

TABLE 2. Good quality aglime soil incorporated immediately prior to planting can significantly increase crop yields.

Lime rate, tons/A	Goldsboro soil Corn yield, bu/A	Pacolet soil Barley yield, bu/A	Frederick soil Alfalfa yield, lb/A
0.0	21	49	303
0.5	87	–	–
1.0	105	61	1,229
2.0	104	56	1,674
3.0	–	56	1,817
4.0	110	65	2,191
6.0	121	60	2,262
8.0	–	59	2,369

Virginia

Virginia Studies

Three acid soils on growers' farms were used for these studies: a Goldsboro sandy loam (Coastal Plain region), a Pacolet sandy clay loam (Piedmont region), and a Frederick silt loam (Valley region). A commercially-available dolomitic aglime, containing 54 percent calcium carbonate and 43 percent magnesium carbonate, was utilized for these studies. The particle size distribution of this aglime was 88, 60 and 50 percent passing 20, 60 and 100 mesh sieves, respectively. The aglime was applied at various rates and incorporated with tillage immediately prior to planting each crop. Corn was planted on the Goldsboro soil, barley on the Pacolet, and alfalfa on the Frederick.

Results

Lime treatments increased surface soil pH at all locations within 16 weeks of application (**Table 1**), and other observations showed measurable increases in soil pH two weeks after aglime application. Exchangeable Ca and Mg levels were increased and exchangeable Al levels decreased with aglime application. These effects are reasonable responses because the aglime particles passing a 100 mesh sieve can be expected to be almost immediately reactive in acid soils.

Corn, barley and alfalfa yields were all increased with aglime applications (**Table 2**). Regression analyses indicated that corn yield increases were strongly associated with reductions in exchangeable Al levels, while first-cutting alfalfa yields were related to increases in soil pH and exchangeable Ca and decreases in exchangeable Al. Barley responses to limestone on the Pacolet soil were limited by severe winter-kill which resulted in variable yield data.

Summary

Soil pH and exchangeable soil Ca and Mg increased, and exchangeable Al levels decreased during the 16-week

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GOOD QUALITY aglime can have immediate effects on crop growth and yield. Corn plants in the foreground are growing on an unlimed area. Liming produced the growth difference shown by plants in background.

sity and Extension personnel advised growers that surface applied aglime worked slowly and that high rates were no more effective than 2 to 4 tons/A. The recommended approach was to apply 2 tons, wait a couple of years, apply 2 more tons, then give the aglime a number of years to become fully effective.

About 6 to 10 years have passed since liming was emphasized in area orchards, and it may be time for assessment and possible re-treatment. Most orchards have built up a "lime debt" of at least 8 to 10 tons/A over the past 20 years, so we will need to continue coming back to this issue for another decade or so before we can return to a maintenance mode.

Soil pH can be sampled any time the soil is not frozen. Samples should be taken from the top 6 inches, 6 to 12 inches, and 12 to 24 inches, taking care to prevent cross contamination between the samples (e.g., sluffing of surface soil into the sampling hole may result in an artificially high pH for the deeper samples). Assessing pH trends at the three depths will indicate the progress of the aglime application. If the pH of the surface 6 inches is well above 7.0, then there is still free aglime present and applying more will not necessarily speed the correction of pH at lower depths. On the other hand, if the surface pH is near or below 7.0, and the second foot is 6.0 or less, the orchard is probably ready for more lime.

Summary

The positive effect of proper soil pH for fruit production is too important to overlook. Trees pick up important nutrients...especially N, calcium (Ca) and phosphorus (P)...much more efficiently when pH is above 6.0. Since considerable time and money can be spent improving the nutrient status of trees by applying various fertilizer products, it makes sense to maximize their potential benefit with a proper liming program. BC

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period following dolomitic aglime application to three acid soils typical of the mid-Atlantic region. More importantly, crop yields were increased, and these increases were directly associated with the changes in soil chemical properties from aglime applications made at planting. Data clearly indicate that crops planted into acid soils do respond immediately to aglime applications. Aglime applications should never be postponed because of the belief that aglime reaction will be slow. Aglime with a relatively high calcium carbonate equivalency (85 percent or greater) and a significant portion (30 percent or more) of particles passing a 100 mesh sieve, will react immediately with soil acidity and increase crop yields.

Finally, one of the most difficult situations for a grower is to suffer yield losses due to acid soils, and then face the prospect of a large cost per acre for liming. Regular soil testing and aglime use must be a part of the farm management program each year so that costs are not too great in any one year, and soil pH values do not fall to levels that result in crop yield reductions. Liming acid soils is the foundation for an efficient crop production program. BC

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