PENNSYLVANIA

Lime Needs under No-till Conditions

By Douglas B. Beegle

Conservation tillage is becoming more and more common in North America. It is usually accompanied by an increase in surface acidity from the long-term surface application of ammonium-containing fertilizers and manures. This lower surface pH can result in aluminum (Al) toxicity which can limit root growth and lead to reduced effectiveness of triazine herbicides.

Pennsylvania studies show that surface applications of aglime in no-till systems primarily affect the surface 2 inches of soil. Still, this change in soil pH can benefit crops and affect herbicide performance.

The effects of liming are limited in the short term to soil in close proximity to the limestone particles. For maximum effectiveness, recommendations call for limestone to be mixed thoroughly with the soil. But, in reduced tillage systems, mixing is very limited. That raises the question for conservation tillage systems, particularly no-till crop production, "Can aglime be applied to the soil surface and effectively change the soil pH?"

Penn State Studies

A study was initiated at Penn State to look at the effects of surface application of lime on a very acid, long-term no-till soil. For the preceding eight years, the field had been in no-till corn production with no aglime applied. The initial pH of the plow layer was 5.1 and the pH of the surface 2 inches was 4.5. The lime recommendation, based on the SMP buffer pH and a target pH of 6.5, was 6,000 lb/A calcium carbonate equivalent (CCE). The study included four aglime rates (0, 3,000, 6,000, 9,000 lb CCE/A) and liming programs ranging from applying aglime every year to once every five years. Each year the soil was sampled in the spring in 2-inch increments to a depth of 6 inches. No-till corn was grown for the first seven years, no-till soybeans for next two years, oats for one year and wheat for one year.

Results

Soil samples were collected in the spring of each year for the first nine years of the study. The recommended liming program, 6,000 lb CCE/A every third year (**Figure 1**), changed the soil pH in the surface 2 inches within the first year after application. Most of the change occurred within the first two months after spring liming. That sort of change was expected because the aglime used was high quality with 90 percent passing a 100 mesh sieve. Spot checks indicated that most of the pH change actually occurred in the surface half inch of soil. There was little change in the soil pH below the surface 2 inches until about the fourth year of the study following subsequent lime applications.

A second program, 6,000 lb CCE/A initially and 3,000 lb CCE/A per year after two years, was of substantial interest because of speculation that more frequent, smaller applications of lime may

be necessary in no-till systems. Soil pH values (**Figure 2**) indicated little difference between the standard program...liming every third year...and the annual lime applications.

Aglime applications resulted in slight increases in corn yield. Yield increases may have been limited by compaction from the liming operation, especially in the more frequent liming programs. Wheat showed the greatest yield response in the tenth year of the study (**Table 1**).

Corn ear leaf samples were analyzed in several years of the study. There were significant effects on plant tissue nutrient concentrations immediately after liming even though the pH effect was limited to the soil surface. Data indicated a significant increase in calcium (Ca) concentrations and a decrease in manganese (Mn) (**Table 2**). The Ca levels in all of the plots were in the sufficient range. The Mn levels in the check and 3,000 lb CCE/A treatments were in the high range and the other two treatments were in the sufficient range for corn. Still, the rapid effect on nutrient availability, when the pH change was limited to the soil surface, was a little surprising. However, this could be explained by increased root growth near the surface in a high residue system.

TABLE 1. Wheat yield response due to liming.

Aglime rate, lb/A	Wheat yield, bu/A
0	52
3,000	69
6,000	71
9,000	69

TABLE 2. Effects of liming on corn ear leaf Ca and Mn in the first year after application.

Aglime rate, lb/A	Calcium, %	Manganese, ppm
0	0.51	198
3,000	0.58	159
6,000	0.57	133
9,000	0.58	122

A triazine weed control evaluation was included in the early years of this study. This work showed that the initial liming which only affected the pH at the soil surface did improve the efficacy of the triazine herbicides. This was expected since many of the herbicides work in this shallow layer near the soil surface.

Summary

This study indicated that surface application of aglime will rapidly change the pH of surface soil. It also indicated

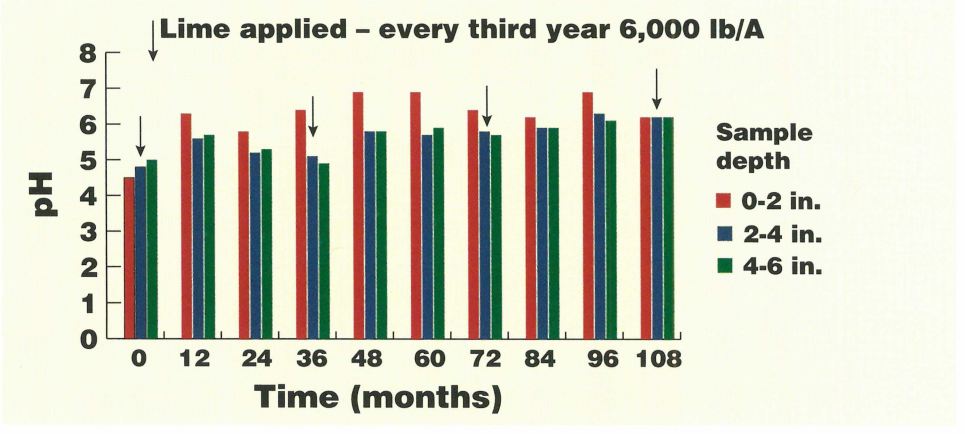

FIGURE 1. Soil pH versus time for a no-till soil limed at 6,000 lb/A every third year.

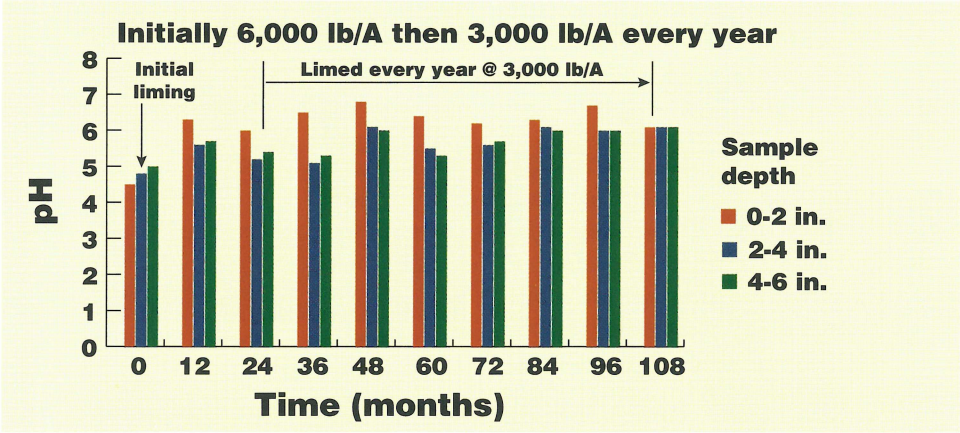

FIGURE 2. Soil pH versus time for a no-till soil limed at 6,000 lb/A initially and then at 3,000 lb/A annually after the second year.

that even this shallow pH improvement could affect herbicide activity and nutrient availability. The study showed that a very long time is required for aglime to have much effect on the soil pH below the surface 2 inches in a no-till system. Finally, there seems to be little justification for more frequent liming in no-till systems.

The current recommendation for liming no-till systems is effective. On an acid soil, aglime should be incorporated to adjust the soil pH to the desired level in the entire plow layer before no-till crop production is initiated. If the soil pH is in the desired range initially, it can be maintained by surface applications of limestone in no-till systems. If a regular liming program is followed and soil pH is not allowed to drop to very low levels, further incorporation of aglime applications should not be necessary. Where incorporation is not possible, there are beneficial effects of surface application of aglime to acid no-till soils even though the immediate effect will only be near the soil surface. Surface liming approximately every three years based on a regular soil testing program should be adequate for no-till systems. BC

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