LIMING IN NO-TILL SYSTEMS[1]

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ABSTRACT & CONCLUSIONS

In 1985 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. Since 1977 this field had been in no-till corn production with no limestone applied. The initial pH of "plow layer" was 5.1 and the surface 2 inch pH was 4.5. The limestone recommendation, based on the SMP buffer pH and a target pH of 6.5, was 6000 lb calcium carbonate equivalent (CCE) per acre. The study included four limestone rates (0, 3000, 6000, 9000 lb CCE/A) and liming programs ranging from applying lime 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 from 1985 to 1991, no-till soybeans were grown in 1992 and 1993, oats was grown in 1994 and wheat in 1995 and corn in 1996 and 1997.

Soil pH results from soil samples taken in the spring of each year from 1985 through 1994 for selected liming programs are given in Figures 1 and 2. The soil pH results for the 6000 lb/A, every third year liming program are shown in Figure 1. This treatment was chosen for illustration because this would be the recommended limestone rate based on a plow depth soil sample and this frequency of liming is fairly common in many areas. The pH results in Figure 2 are from the every year, 3000 lb/A liming program. The every year program is of interest because there has been speculation that more frequent smaller applications of limestone may be necessary in no-till. Several observations can be made based on these results. First, it is clear that the recommended limestone application changed the soil pH in the surface 2 inches within the first year after application. Soil pH measurements taken within the first year indicated that most of the pH change in the surface layer occurred within the first two months after spring liming. This rapid increase at the surface was expected since this was a high quality finely ground limestone with 90% passing a 100 mesh sieve. Although the 0 to 2 inch layer was not subdivided for routine pH determination, spot checks of pH in this layer indicated that most of the pH change was in the surface 1/2 inch. However, there was little change in the soil pH below the surface 2 inches until about the fourth year of the study following subsequent limestone applications. Even after 9 years the soil pH in the 2 to 6 inch layers has not yet reached the target pH of 6.5 that was achieved rather quickly in the surface layer. There is little apparent difference between the standard, every third year liming program, and the more frequent every year liming program.

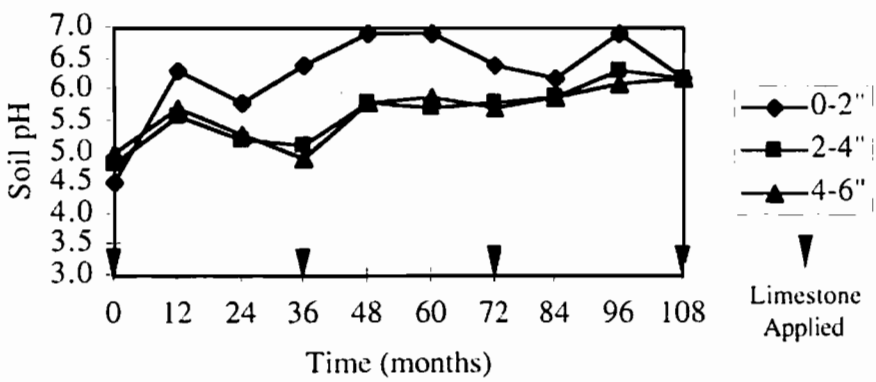

Figure 1. Soil pH vs time for a no-till soil limed at 6000 lb/A every third year.

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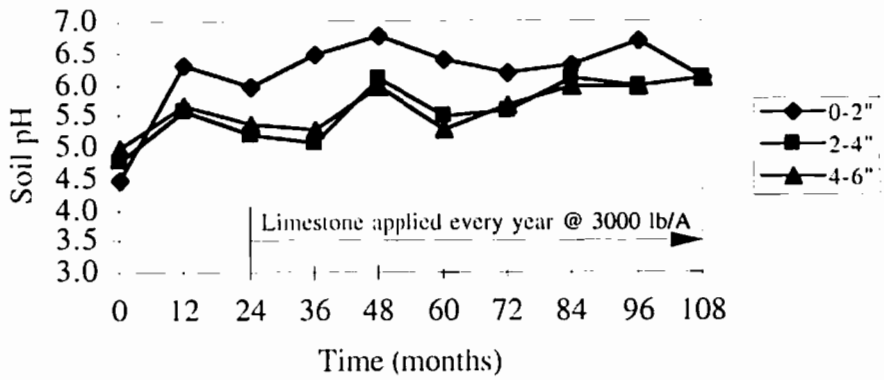

Figure 2. Soil pH vs time for a no-till soil limed at 6000 lb/A initially and then every year since 1987 at 3000 lb/A.

These pH effects from the liming treatments resulted in slight but generally insignificant increases in corn yield. The greatest yield response was in the wheat crop in 1995. Some negative responses were observed in the years when soybeans were the plots. However, it was speculated that this was due to compaction from the liming operation especially in the more frequent liming programs. A triazine weed control treatment 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. Similar to the effect observed with the triazine activity, there were significant effects on plant tissue concentrations immediately after liming even though the pH effect from the lime was limited to the soil surface. These plant nutrient effects were a significant increase in calcium and a decrease in manganese. From this work it was concluded that surface application of limestone will rapidly change the soil pH at the surface of the soil. It was also observed that even this shallow pH improvement could affect herbicide activity and nutrient availability. A second major conclusion is that a very long time is required to have much effect on the soil pH below the surface 2 inches in no-till crop production. Finally, there seems to be little justification for more frequent liming in no-till systems.

Thus, the current recommendation is that where possible on a very acid soil, limestone should be incorporated to adjust the soil pH to the desired level in the entire plow layer before no-till crop production in initiated. Other work has shown that if the soil pH is in the desired range to begin with, it can be maintained by surface applications of limestone in no-till systems. Thus, if a regular liming program is followed and soil pH is not allowed to drop to very low levels further incorporation of limestone should not be necessary. Where incorporation is not possible there are beneficial effects of surface application of limestone to acid no-till soils even though the immediate effect will only be near the soil surface. Also, with surface liming the standard every three year or so liming program based on a regular soil testing program should be adequate.

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