Timing of Lime Application for Field Crops

Liming of soils to an optimum pH is important for both crop production and nutrient management. Agronomy fact sheets 5 and 7 addressed pH and liming materials. In agronomy fact sheet 6 the different forms of acidity were explained and it was shown how to derive a lime recommendation from a soil measurement of exchangeable acidity and knowledge of the initial field pH and the crop rotation. In fact sheet 48 we explained how to derive a lime recommendation from a buffer pH measurement. This agronomy fact sheet provides guidance on the timing of sampling for pH management and timing of lime applications for field crop rotations.

Seasonal Fluctuations in Soil pH

Soil temperature and moisture change during a growing season and these changes can impact soil properties such as the pH of a soil. Research has shown that soil pH values tend to be lower in drier summer months and higher in wet spring and winter months (Figure 1).

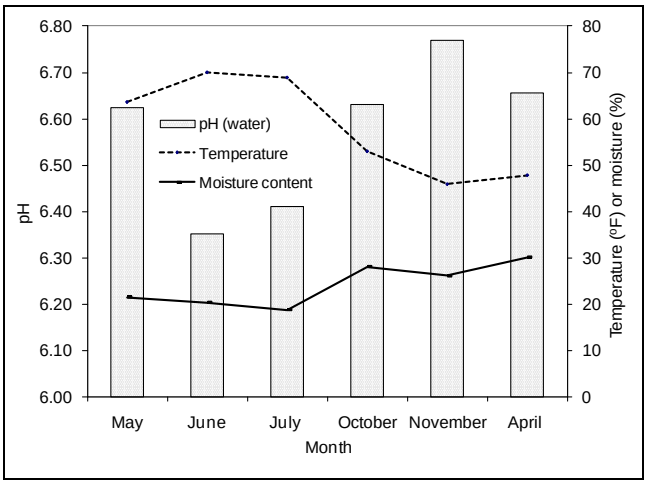

Figure 1: Soil pH tends to be lower in the warmer and drier summer months than in the rest of the year.

This fluctuation in pH can occur for several reasons. First, as the soil dries in the summer months, the salt concentration increases. Soluble cations such as Ca, Mg and K replace exchangeable H^+ or Al^{3+} ions on the surfaces of the soil particles. The H^+ or Al^{3+} ions enter the soil solution which then becomes more acid. In wet months, salt concentrations tend to be lower. In drier conditions oxidation processes (such as conversion of ammonium to nitrate, decomposition of organic matter) can generate acidity as well. In addition, microbial respiration in the warmer months produces more CO_2 which forms carbonic acid, a weak acid that also contributes to a decrease in soil pH. On the other hand, CO_2 is more soluble at lower temperatures so the net effect of CO_2 on soil pH can be variable.

The seasonal trends in soil pH are shown in Figure 1. This figure summarizes the pH trends of twenty New York corn fields and shows an average fluctuation of 0.4 pH unit.

Timing of Sampling and Lime Application

To neutralize only the active acidity (measured as pH), very little lime is needed and the conversion is rapid. However, such a change would be very short-lived because of the existence of salt-replaceable and residual acidity (see fact sheet 6). The amount of lime needed to neutralize salt-replaceable acidity is much greater. As water flows through the soil profile, lime will be carried downward and gradually increase the subsoil pH. This process of pH increase of the soil profile can take years and the only practical method to speed up this process is by mixing lime directly with soil, most commonly through tillage.

Conventional tillage systems

For rotations that include alfalfa or soybeans (crops that have an optimum pH of 7.2), and where the soil pH is 6.0 or less, lime should be applied at least six months before seeding for the lime to react with the entire plow layer. Ideally, lime is applied the spring before alfalfa or soybean is planted to ensure optimal pH in the seeding year. Soil testing for pH management should occur prior to the last crop before alfalfa or soybean, preferably in the fall. For example, in a 4 year corn and 4 year alfalfa rotation the optimal time to sample for soil pH and buffer pH is post harvest in

corn year 3. This allows for lime application that fall or in the spring, prior to the 4th year of corn planting allowing for two plowing cycles.

Lime will react more rapidly if it is worked into the soil, so if there is insufficient time for an adequate reaction with the entire plow layer (i.e. less than two plowings), at least one-half of the recommended lime rate should be added to the surface and disked in before the seeding to provide a favorable pH in the soil zone near the legume seed to encourage good establishment. Smaller applications necessary to maintain a pH above 6.2 or 6.5 can be made at any time before a seeding and can be either applied to the surface or plowed down.

If the soil pH is 5.5 or below, a less sensitive crop such as corn or clover should be planted for a year before planting alfalfa and split applications of lime should be considered. For fields that do not have legumes in the rotation but require lime to maintain a pH of 6.2 or 6.5 for corn, grass or small grains, it is recommended to do the lime application directly after second or third cutting of hay when soils are dry and best able to support heavy lime application equipment, thus minimizing the risk of soil compaction. Also, as the sod re-grows, it will help prevent runoff of the lime should heavy rains occur on fields that are prone to runoff.

No-till systems

Good lime to soil contact will help maximize the effectiveness of liming material. In no-till systems, lime moves into the soil profile at a very slow rate because it is surface applied and not mechanically mixed into the soil and surface. Similarly, it will likely take more time for the entire soil profile to increase in pH upon broadcasting of lime in reduced tillage or vertical tillage systems. Therefore, these systems need to be closely monitored for pH changes over time; soil samples should be taken more frequently and more frequent lime additions might be needed. For no-till or reduced tillage systems, the pH values of two soil layers (0-1 and 0-6 inches) need to be considered and it is recommended to sample the soil for pH, at least a year prior to rotation to a pH sensitive crop like alfalfa or soybeans. As was listed in agronomy fact sheet 6, depending on the results of the pH measurements, there are three management options, each with their own guidance for timing of application:

- If the pH of the surface 0-1 inch is low, but the pH of the 0-6 inch zone is adequate, add 1 to 1½ tons of lime per acre to raise the pH of the soil surface.
- If both layers are strongly acidic do not use no-tillage methods for the establishment of legumes until lime has been given 6 to 9 months to react with the soil.
- If the surface (0-1 inch depth) pH is adequate, but the 0-6 inch soil zone has a low pH, legumes might be no-till seeded with a slightly lower overall pH or without waiting as long for the lime to react as when both zones have a low soil pH.

For a given amount of acidity, a corresponding amount of liming material is needed regardless of the fineness of the material but lime particles passing a 100-mesh screen will react within the 1st year versus a longer reaction time for larger particles. So, if a quick change in pH is needed, a lime source with a high fineness factor (powdery liming material) is recommended.

In Summary

Timing of sampling for soil pH and timing of lime application are two important aspects of proper lime management for optimal crop production.

Additional Resources

- Cornell agronomy fact sheets #1 (Soil sampling for field crops), #5 (Soil pH), #6 (Lime recommendations for field crops), #7 (Liming materials), and #48 (Buffer pH to derive lime guidelines) downloadable from: http://nmsp.cals.cornell.edu/publications/factsheets.asp.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

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