National Fertilizer
Solutions Association

FLUID FACTS

NFSA AGRONOMIC NEWSLETTER

MANAGE SOIL pH FOR OPTIMUM CROP RESPONSE

Soil acidity is a complex issue. It has many facets that affect plant nutrients and their availabilities. It also changes the numbers and proportions of bacteria and fungi in the soil. Soil testing and liming and fertilizer experiments have been used to develop specific recommendations (lime requirement) for different soils throughout the U.S. and Canada.

A recent pH Soil Test Summary map (Figure 1) shows the percentage of soils testing pH 6 or less. Note that soils of the Northeast, Southeast and Northwest tend to have the higher percentages of acid soils. These acidic soils result from the parent materials from which the soils were formed, the age of the soils, local vegetation and climatic conditions (rainfall and temperatures).

SOIL pH DYNAMICS

As soil pH decreases through weathering and cropping, essential nutrients ("exchangeable bases"), such as calcium (Ca^{2+}), magnesium (Mg^{2+}) and potassium (K^+) are removed from soil organic matter and clays and are replaced by hydrogen ions (H^+). This process, of course, changes the chemistry of the soil. As acidity increases the amounts of exchangeable aluminium (Al^{3+}), iron (Fe^{2+}) and manganese (Mn^{2+}) increase, the soil chemistry tends to "tie up" phosphorus, making soil and fertilizer phosphates less available to crops. These metals, particularly Al, can be quite toxic to plant roots.

Also, as soils become more acid, microbial populations tend to shift from bacteria to fungi, changing the rates of soil organic matter mineralization of nitrogen, phosphorus and sulfur. Mineralization of ammonium-N fertilizer sources to

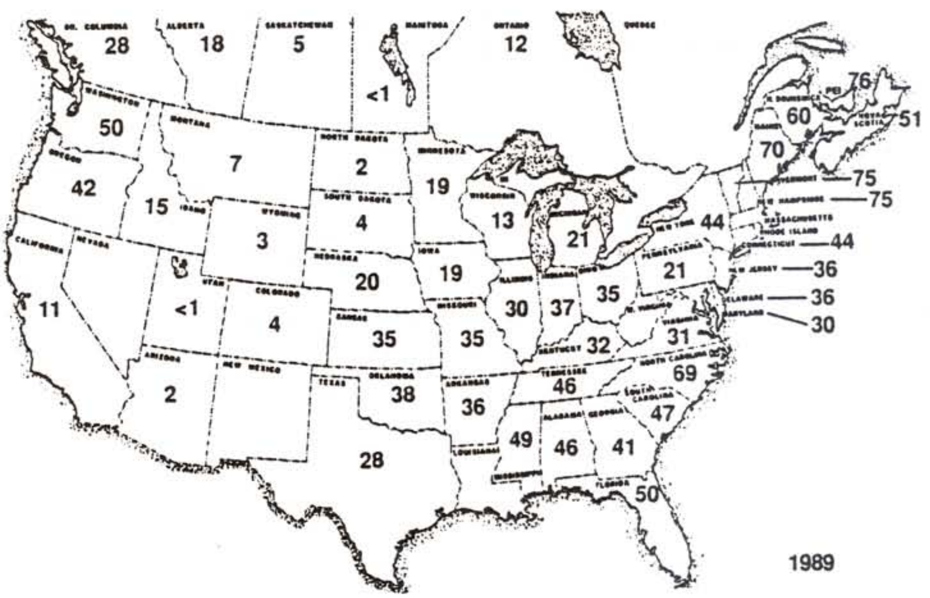

FIGURE 1. *pH soil test summary showing percent of samples testing pH 6.0 or less. Courtesy of* Better Crops, *Spring 1990, Potash & Phosphate Institute.*

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nitrate also will be influenced. Under long-term, intense weathering these changes occur deep in the soil profile, making it difficult for roots to grow and use subsoil moisture and nutrients, which would be available to crops under more normal conditions.

As soil acidity increases (pH decreases), the availability of molybdenum (Mo), a very important micronutrient, decreases. Aluminium and iron oxides also decrease Mo availability. This element is a key part of two enzymes (catalysts) needed for nitrogen conversions in legumes and other crops.

In legumes, the enzyme "nitrogenase" requires Mo for the nitrogen fixation process. In crops that take up nitrate-nitrogen, the enzyme "nitrate reductase" requires Mo to convert nitrate to plant proteins. Liming usually should increase Mo availability. But Mo availability still may be relatively low at pHs of 5.5 which usually decreases levels of exchangeable Al enough for good crop production.

As soil acidity decreases (pH increases) through liming, the availability of boron (B), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) tend to decrease. In some cases, if lime requirements are over estimated, micronutrient deficiencies actually can be created. In well-managed soils that is rare.

MANAGING SOIL pH

Long-term use of relatively high N rates can decrease soil pHs enough to cause problems. For example, surface applied N in no-till corn over time may decrease pH in the top couple of inches of soil enough to make triazine herbicides relatively ineffective. Surface liming could correct the situation.

Soil pHs are decreased from long-term use of N in crop production. This has happened both in wheat and corn production, especially in low exchange capacity, poorly buffered soils. (A highly buffered soil is one that resists a change in pH when acid-forming fertilizers are applied.)

Decreases in soil pH from N use are not "bad," as can be seen from the corn yield data shown in Table 1. Farmers and dealers must be aware of the soil pH changes and periodically apply limestone. This is particularly important where subsoils are acid.

Table 1.

*Effect of N rates on soil pH and corn yields.**

N RATE	SOIL pH	CORN YIELD
	LB/AC/YR	BU/AC
0	6.6	46
80	6.4	122
240	5.7	156

These data are from the Scandia Branch Station, Kans.

FALL LIMING

Liming usually is part of the soil fertility answer to acid soils and provides the following benefits:

- Adds Ca and Mg essential for crop nutrition;
- Precipitates Fe, Al and Mn which may be toxic to plants and/or tie up soil and fertilizer phosphorus;
- Increases soil phosphorus availability;
- Increases molybdenum availability;
- Stimulates soil microorganisms, particularly bacteria, which help release nutrients from soil organic matter.

On soils high in exchangeable Al, you usually need to lime only to pH 5.5 to decrease soil Al concentrations enough to produce profitable yields. You then need to adjust soil levels of exchangeable K, Ca, Mg and micronutrients to be certain levels are adequate to ensure optimum growth response for local conditions.

If subsoils are very acid and high in exchangeable Al, you may need to consider applying calcium sulfate in amounts high enough to move the sulfate anion deeply enough to block subsoil Al. This should increase the availability and use of subsoil moisture. Usually, calcium and magnesium carbonates move only very slowly in soils and, except on very sandy soils, will have little effect on decreasing subsoil Al unless deeply tilled or mixed into the soil.

Fall is a good time to apply lime. Lime can be well mixed into the soil and have time to react and help adjust soil pH for the next crop. Proper liming is an important part of soil fertility management. It will tend to decrease the downward mobility and potential loss of K from the root zone. Proper liming in general doesn't cost, it pays.