Acid Soil:
Prevention May Be Cheaper Than Cure

by Meryl Rygg McKenna

There is so much more to dirt than meets the eye. Along with nutrients, texture, organic matter and so on, soil pH is critical to the health of plants.

Ongoing soil tests show fields are becoming more acidic. At least 20 of Montana's agricultural counties have soils acidic enough to affect crop health, even in areas traditionally known for high-pH (alkaline) soils.

A pH value is a measure of acidity on a scale from 0 to 14. Acidic soils have low pH values -- less than 7; basic soils have high pH values -- greater than 7; and pH 7 is neutral. Each pH unit change represents a 10-fold change in acidity.

Stunted plant growth here is a result of acidic soil. Photo courtesy of R. Engel.

Why does it matter?

Acidic soil affects crop health in multiple ways, said Clain Jones, chair of the Rocky Mountain Certified Crop Adviser (CCA) program and Extension Soil Fertility Specialist with Montana State University. As soil pH drops, plants go hungry because nutrients are less available than in neutral-pH soil. For example, at low pH, phosphorus sticks more to clay or iron particles, while nitrogen, potassium, sulfur, calcium, and magnesium are easily leached away and lost. Nitrogen fixation by legumes is severely limited at pH levels lower than 6.

At low pH, aluminum and manganese become more available, leading to toxic levels that produce yellow, brown or even pink foliage and poor growth, especially once pH falls below 5. Too much aluminum creates plants with club- or broom-shaped roots. Farmers also see an increase in some fungal diseases such as Rhizoctonia and Cephalosporium stripe.

As pH levels go down, the effectiveness of herbicides and pesticides changes, as well as how long they stay in the soil, possibly resulting in crop damage.

Rick Engel takes soil samples from a field showing signs of aluminum toxicity, one of the results of acidic soil. Photo courtesy of R. Engel.

What makes soil more acidic?

Some soils have naturally low pH levels, such as forest soils and those that receive high amounts of precipitation. Soils coming from granite sources have lower pH than those from chalky or limestone sources.

However, certain farm procedures also contribute to the change in soil acidity. One is the practice of applying more ammonium-based nitrogen (N) fertilizer than a crop needs or can use; high N rates are often applied because they frequently produce high yield, protein, and profit.

Chuck Gatzemeier, a CCA in Glacier County, Mont., said acidic soil was already an issue in Idaho and parts of Canada's Prairie Provinces before he began seeing it in Montana around 10 years ago.

"The primary source of soil acidification, in my perspective, has been farmers planting wheat on wheat on wheat, fertilizing for high yields and high protein without soil sampling first to find out how much N is needed," Gatzemeier said.

Jones explained what happens when too much N is added. Ammonium or urea fertilizer combined with air and water produces nitrate plus acid. When nitrate is not taken up by plants it leaches out of the soil and acid is left behind.

Removal of crop residue adds to acidity in that it takes away calcium, magnesium and potassium, which "buffer" pH drop. For example, if oat straw is removed with the grain harvest, Gatzemeier said the amount of lime required to counter the acidifying effect is six times greater than if the straw stayed on the field.

Because fertilizer is generally applied to the surface or in the top few inches of soil, acidity concentrates in the top 3-6 inches. Fortunately, farmers can prevent and remedy acidic soil.

Significant crop damage results from soil being too acidic, as shown in this drone image. Photo courtesy of S. Powell.

Prevention and mitigation

To prevent soil from becoming too acidic, Gatzemeier said CCAs advise farmers to have soil samples assessed every year. “Look at your nitrogen level, especially in the top 6 inches of soil,” he said. “Look at the amount of organic matter in that same sample, and look at the pH level every year. If the pH level is going down (becoming more acidic), what you’re doing needs to change.”

Depending on a field’s location, Gatzemeier said soil with 2 percent organic matter is good. When more organic matter is present in the soil, more N will be released as the previous year’s roots decompose -- which can lower fertilizer N needs.

If the organic matter is 3 percent or more in the top 6 inches, count on at least 10 to 20 pounds of N per acre being released into the soil from that organic matter. A similar release is expected after a pulse crop is grown for grain. Subtract that amount from the recommended N application rate.

Aerating, using vertical tilling machines that open up soil with serrated disks, has become common in Idaho and Canada as a remedy for acidification. Gatzemeier said many Montana farmers, too, now till on a four-year cycle and find it very helpful.

Farmers can also mix soil from 8 or 10 inches deep (higher pH level) with the low-pH soil from shallow depths, but with caution. If doing so will only make the acidic layer thicker, more lime could be required later to correct it, at substantial cost for delivery and application.

Lime is a common remedy, but it takes a large amount and it must be worked into the soil. Because acidity is a relatively new issue in Montana, there are not many sources of readily available agricultural lime, though spent sugar beet lime is free in Billings and Sidney, Mont. Lime is not used to prevent acidification.

Crop rotation is especially useful when crops that require little N such as legumes are included. Perennials have actually been shown to reverse acidification (though slowly) in North Dakota.

As always, the four Rs apply: When fertilizing, always use the Right source at the Right rate, at the Right time, in the Right place. Follow these four guidelines for every crop, every year.

For more information on the certified crop adviser program, or to find one near you, visit http://www.certifiedcropadviser.org.