Hybrid Response to High pH Soil

Soils that are high in pH can be found in many areas of the Central and Western Corn Belt. Some high pH soils, particularly those found in parts of Nebraska, Kansas, Colorado, Wyoming, and Montana can be problematic for crop production. They can limit a farmer's crop selection options, eliminating soybean as a possible rotational crop, for example. Even in the case of an adapted crop, such as corn, genetic differences in tolerance to high pH can impact both the growth and development and the eventual yield potential of the crop. In these situations, careful hybrid selection can be the most important factor determining economic success or failure.

What is pH?

Every solution has a pH. It is a measure of how acid or alkaline the solution is, and is based on the concentration of free hydrogen ions present in that solution. Hydrogen ion concentration is measured using a logarithmic scale of 0.0 to 14.0. Substances having a pH less than 7.0 are considered acidic (more free hydrogen), and substances with a pH greater than 7.0 (less free hydrogen) are considered alkaline or basic. Common examples of acid solutions include coffee, sodas, and vinegar, while bleach is an example of an alkaline solution. Distilled water has a pH of exactly 7.0, and is considered a neutral pH solution.

In the case of soil, pH is a measure of the acidity or alkalinity of the soil solution surrounding the soil particles and plant roots. A particular soil's pH is primarily a function of the parent material that soil was derived from combined with the climate where the soil is located. Parent materials high in calcium, magnesium, and/or sodium are commonly associated with high pH soils, as is a drier climate. How eroded a soil is and/or management activities can also influence soil pH. Over-liming an acid soil can raise soil pH out of the optimum range and is an example of how a management activity can influence soil pH.

Importance of Soil pH

Soil pH is important because it affects availability of key plant nutrients. It also influences behavior of chemicals, like herbicides. The optimum soil pH range for corn is 5.6 to 7.5. Almost all corn hybrids tolerate soil pH levels of 7.5 to 7.8, but as soil pH continues to rise above 7.8, corn growth and yield potential become more limited and hybrid selection becomes increasingly important. In fields where high soil pH is severe enough to influence corn growth, plants often appear stunted and leaves exhibit a symptom called chlorosis. Chlorosis is a light-yellow coloration of leaves due to low amounts of chlorophyll, and is shown in figure 1.

Figure 1. Corn plant showing symptoms of chlorosis due to high pH soil.
Photo courtesy of Syngenta.

The severity of corn response to soil pH greater than 7.8 is greatly influenced by the amount of available calcium and/or sodium in the soil solution (calcium is sometimes expressed on a soil test report as excess lime and/or percent carbonate). Greater amounts of one or both elements are typically more detrimental. Finally, organic matter can influence the pH response of corn. For example, corn growing on an 8.0 pH soil with high calcium and 3 to 4% organic matter in Minnesota will seldom show a negative pH response, while corn growing on an 8.0 pH, calcareous soil with 1 to 1.5% organic matter in Western Nebraska will be stunted, chlorotic, and yield will be reduced without careful hybrid selection.

Hybrid Selection for High pH Soil

The first consideration for managing corn on high pH soils is to take a representative soil sample of the field to determine soil pH, and calcium and sodium content. If the pH is above 7.8 and the soil test indicates high available calcium and/or sodium, the next step is to consider the historical reaction of hybrids planted on that field. If no past consideration has been given to a pH response rating and corn has developed normally (absence of stunting, chlorotic symptoms, or depressed yield), then the high pH is not severe enough to be of concern and the field can be managed using normal management considerations. If the field, on the other hand, has a history of producing corn that shows stunting, chlorosis, and depressed yield, hybrid ratings for response to high pH soil should be a primary consideration.

The final step in a management plan is to match a hybrid to the high pH conditions in the field using the Rob-See-Co ratings for hybrid response to high pH soil. Figure 2 illustrates differences in hybrid response to high pH soil and was taken at the Syngenta High pH Screening site near Merino, Colorado. Hybrids in this photo show a full range of negative effects from the high soil pH. The hybrid in the middle two rows shows severe chlorosis and stunting, while the hybrid to its right shows moderately severe chlorosis and less stunting. The hybrids on the far left, far right, and to the back of the photo are growing normally, which reflects their genetic tolerance to high soil pH.

Figure 2. Range in hybrid response to high soil pH.
Photo courtesy of Syngenta.

Using the Rob-See-Co Hybrid Ratings for High pH

Rob-See-Co uses our four-category rating system to characterize a hybrid's tolerance to high pH soils. Here are guidelines on how to use this rating system when selecting hybrids for fields with high pH soil:

- Hybrids with a ● rating are the best choice on high pH soils with a high excess lime rating and/or soils that contain high enough levels of sodium to negatively impact crop development.
- Hybrids with a ◕ rating are a good choice for soils with a pH of 7.8 and greater, including soils with a high excess lime rating, but are not as well suited for soils with high levels of sodium.
- Hybrids with a ◑ rating should be used on fields with soil pH of 7.8 or lower, or on neutral to moderate pH fields that contain small, isolated pockets of severe pH.
- Hybrids with a ⊗ rating should not be planted on fields with a soil pH greater than 7.8.

Hybrid Selection Guidelines for High Salt Soils

Hybrid adaptation to high salt soils is primarily influenced by drought tolerance. Use the Rob-See-Co rating for drought tolerance to determine hybrid fit for salty fields. Focus on hybrids with a drought tolerance rating of 7 or higher. If the soil is both salty and has a high pH, select hybrid(s) based on both drought tolerance and pH response ratings.