Soil Health Applied Research Alliance

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ARECA Soil Health Initiative

This article is part of a series to promote better understanding of our agricultural soil resources along with practices that can influence soil health.

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What does soil chemistry say about soil health?

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Farmers invest millions annually in soil testing services to fine tune fertilizer rates or help diagnose specific field production issues. While there are different schools of thought on the most appropriate field sampling methods and choices with respect to commercial labs, most soil test reports provide some useful information on soil chemistry. And, soil chemistry is an important indicator for soil health.

Soil chemistry will vary across field landscapes based on the complex of soil types – shaped by factors like the minerals deposited following the last glaciation and the influence of climate and groundwater over the past few thousand years of soil development. Adding to that was the significant soil impacts following settlement as large tracts of land were plowed, contributing to widespread erosion and salinization.

Most soil testing is done to inform fertilizer requirements – analyzing for macro-nutrients like nitrogen, phosphorus, potassium (K^+) and sulphur with the option to look at micro-nutrients like copper, zinc, boron and others. Depending on lab procedures and extraction methods, these tests along with other soil characteristics (described below), will help determine the likelihood for crop response to added fertilizer – this topic will addressed further in a future article in this series.

In addition to crop available nutrients, most labs can provide other valuable information like organic matter content, pH and soil salinity. Labs can also analyze for important nutrients like calcium (Ca), magnesium (Mg) and sodium (Na) – positively charged minerals (cations) that are important for plant growth and development, or negatively charged nutrients (anions) like chloride (Cl).

Soil organic matter (SOM) is perhaps the most important non-nutrient soil chemistry measure and is addressed in another article. Soil pH is a measure of the relative soil acidity or alkalinity with values near 7 considered “neutral” and lower or higher values more undesirable for most crop types. Lower pH can result in toxic levels of aluminum and can negatively affect soil biology – such as with nodulation for some legume crop types like peas or alfalfa. Soil pH levels from 7 to 8 usually indicate the presence of calcium carbonate (lime) in the topsoil, possibly mixed into the subsoil with past tillage or salt depositions from shallow groundwater at some point in the past. With elevated pH, soil phosphorus is more easily bound to calcium and magnesium ions, often requiring higher annual application rates to maintain crop yields. Levels above 8 suggest a soil salinity issue, discussed below.

Soil salinity is usually related to the inherent soil type characteristics but is also aggravated by land management. For this reason, salinity issues can be very challenging to manage and will be addressed in a future article. For soil test reports, salinity is usually described as the electrical conductivity (EC) for a saturated soil paste extract which is a measure of the total dissolved salts. EC levels of 2 or more will begin to affect plants and salinity levels often increase with depth. Higher soluble salts affect the plants ability

to absorb soil moisture through the process of osmosis, but there are also toxicity issues and nutrient imbalances resulting from saline soils, depending on the salt type, levels and crop type. Another aspect of soil salt issues is the Sodium Adsorption Ratio (SAR).

While it may not directly influence plant nutrient uptake, higher amounts of Na will negatively influence soil structure. These naturally occurring sodic soils have a relatively higher ratio of sodium to calcium plus magnesium ions – measured in the lab as the SAR. The mechanism is complex but the net result are soils with poor water permeability that can be challenging to farm and may respond to calcium based amendments that improve soil structure over time.

Soil test reports often report the soil cation exchange capacity (CEC), reflecting the soils ability to hold and release various cations required for plant growth. CEC can be likened to the soil cation bucket size, increasing with clay content and SOM. Fortunately, our Northern Great Plain soil types tend to have relatively high CEC values compared to other regions.

Soil test reports not only inform on fertilizer requirements but also provide some good indicators about soil health and farmland productive potential that can be tracked over time. This includes soil organic matter, soil nutrient content – not only the major nutrients like N, P, K and S but also micro nutrients and other cations like Ca, Mg and Na or anions like Cl. Other important things to understand and track over time include soil pH which reflects the relative acidity or alkalinity and the EC or SAR which is an indication of a saline or sodic soil condition.