Humic Acid and Returning Soil

To A Healthy State

PART 1:

Humic Acid and the Role of Ionization in Soil Structure, Drainage and Water Retention

Soil science starts with the identification of soils into three basic types: Clay, Silt (Loam), and Sandy. Most agricultural soils are a combination of the three types in varying degrees of content depending on your geographic area and how lucky the area was the last time a glacier passed by. For the purposes of explaining the role of humic acid, we will limit discussion to soils that are primarily Clay or Sandy only. If you're lucky enough to have a farm located on primarily Silt/Loam soil, congratulations and take care of it.

Clay Soils

Clay soils have the smallest particle size of all soils. Soils with high clay content are prone to becoming dense and compact, so much so that they may resist plant rooting. Sculptors and pottery aficionados may like the feel of wet clay, but plants do not.

Clay particles are a very orderly bunch and will normally lay together flat, separated only by a negative ion charge across the face of each particle. The sides of the particle normally carry a positive charge. In and of itself, this arrangement poses no problem to the soil structure and its ability to accept and hold water. But, problems surface when salts are added to the soil via continued, and sometimes excessive fertilization. Salt oversaturation in clay soils causes the negative charge that separates clay particles to become neutralized, allowing the particles to move closer together and the soil to become increasingly dense. In worst case scenarios, with soils where the amount of clay in the soil is very high, the positive charge on the edge of a clay particle may combine with the negative charge on the flat surface of another. The resulting soil becomes like concrete to plant roots that struggle to find their way around this dense compaction layer.

Humic acid has several effects on clay soil. It isolates and removes the salts from the clay particle, re-imparting a negative charge to the face of the particle. A carboxyl group (carbon) on the humic acid molecule is attracted to the positively charged edge of the clay particle, breaking the positive/negative ionic bond between multiple clay particles. The clay particles will then basically “stand on end”, which allows significantly better water penetration.

This entire process is commonly referred to as “colloidal action,” loosening soil and allowing the plant roots to penetrate and move deeper. Long-term use of humic acid has been shown to create a less dense, better drained soil capable of significant yield increases.

Sandy Soils

Although you might be quick to disagree after spending a long a day at the beach and trying to get sand out of various places you don’t want it in, sandy soil actually has the largest particle size of all soil types. Sandy soils will drain quickly, which makes them relatively easy to cultivate and work. That same characteristic also means that sandy soils have nearly zero ability to transport water from deeper layers through capillary action. They will warm up more quickly in spring than clay soils, but are generally low in plant nutrients which are quickly washed out by rain.

One of the great benefits of using humic acid on sandy soils is its ability to slow water evaporation. This is done via an ionization process. When water is present, positive ions (cations) absorbed by humic acid will partially ionize, restoring a part of the bonded ion's positive attractive force. Water is electrically neutral, (dipolar), and the end of the molecule containing the oxygen atom loosely bonds to this ion. The hydrogen (negative) end of the water molecule is partially neutralized, increasing that end's positive attraction. This action continues until the attractive force of the water molecule is dissipated, which reduces the evaporation rate by about 30%. Humic acid can increase water holding capacity in sandy soils, significantly reducing water evaporation and increasing its availability for use by plants.

Part 2:

Increasing the Level of Humus in Soils

Regardless of your soil type, returning organic material to increase humus levels is critical to long-term soil health. A large percentage of soils utilized for production agriculture have been heavily over-cropped and much of the original organic matter (humus) significantly reduced. In the last hundred years, farming practices have resulted in overuse and destruction of soil humus, which is the plant and animal residues deposited in the soil over time in various stages of decomposition. Growers focused on what they knew would increase yields. Technology and scientific testing have only recently begun to tell us what we really need to be doing to find that balance between profitability and stewardship. The cultivation and harvesting of crops (without post-harvest reintroduction of organic matter), increased drainage and irrigation, and the chemical stripping of micro-nutrients and micro-organisms that help hold the soil in place have negatively affected the humus balance of most agricultural soils.

In recent years, in part due to increased government regulatory actions and the concerns of environmental scientists, the fertilizer industry has increased efforts to educate growers on maintaining the humus content of soils. And, growers themselves have come to the realization that returning depleted soils to normal soil humus levels and maintaining those levels will allow them to see increased yields in varying conditions with less use of fertilizers and other inputs. They save on costs, see better yield returns, and maintain their role as stewards of the land.

When organic material (plant & animal matter) is added to the soil three actions occur. First, much of the material is converted to carbon dioxide, water, and energy via enzymatic oxidation. Second, nitrogen, phosphorous and sulfur are either released or immobilized in separate reactions. Third, microbial resistive compounds are formed through microbial synthesis. During these changes in the soil organic matter, simple products, such as carbon dioxide and water, appear immediately. Other products, such as nitrate nitrogen, appear only after the initial peak of activity has subsided. Humic acid helps chelate micronutrients, increasing the plant uptake. Humic acid also increases ion exchange capacity in the soil, which leads to better retention and utilization of soil nitrogen.

By supplying the soil with sufficient humic acid, we can bind cations (positively charged elements) and increase cation exchange capacity. Humic acid can chelate positively charged multivalent ions (Mg, Ca, Fe and other trace minerals) which fortifies plant cell wall structure. By chelating these ions, humic acid facilitates the uptake of the ions, lessening precipitation (leaching through the soil) and increasing bio-availability.

Feed the Microorganisms, Then the Plant

Humic acid is a source of phosphate and carbon, stimulating microflora populations and providing places for microflora to colonize. The bacteria secrete enzymes. These act as catalysts, freeing up calcium and phosphorous (from insoluble calcium phosphate), and iron and phosphorous (from insoluble iron phosphate). As these elements are freed, they are absorbed by the humic acid, making the elements less available to the bacteria. This cycle continues as bacteria are further stimulated to secrete additional enzymes, freeing up more and more calcium, iron, and phosphorous. The process continues until both the humic acid and bacterial populations are “full.”

Humic acid is a bit of a chameleon. It acquires positive ions under one condition and releases them when conditions change, depending on the availability of a different ion to replace the one released. Humic acid holds cations (positive ions) to be absorbed by a plant's root, improving micronutrient exchange and movement into the plant's circulation system.

Although this process in not entirely documented, it is thought that as the plant absorbs water, the humic acids (carrying absorbed micronutrients) move nearer to the root system (which is negatively charged). The root's negative charge exceeds the acid's negative charge and micronutrients are released from the humic acid molecule, entering the root. So, the addition of humic acid to the soil is extremely important for increased movement of nutrients from the soil to the plant.

Part 3:

For the Long Term

Increasing the humus level in your soils is not only good for the environment but it also pays economic dividends. The amount and frequency of fertilizer inputs is reduced, tillage is reduced and cultivation easier. It is not a short-term fix, but is instead a long-term commitment. There are many methods of returning organic material to the soil, with the efficient breakdown of crop residue being the most obvious, but also the use of cover crops of various types (legumes, grasses, non-food root vegetables, etc.), application of animal manures, and so on. We urge growers to work with their agronomic advisers, government agencies, and university professionals to perfect your plan.