HUMIC ACID: THE SCIENCE OF HUMUS AND HOW IT BENEFITS SOIL

By Michael Martin Meléndrez

Humic acid is a group of molecules that bind to, and help plant roots receive, water and nutrients. High humic acid levels can dramatically increase yields. Humic acid deficiency can prevent farmers and gardeners from growing crops with optimum nutrition. Conventional wisdom today ignores humic acids, though, holding that it is impossible to grow and maintain an urban landscape such as a park, golf course, or lawn without high-analysis NPK fertilizers.

This article will drill down into the details on humus. We can adjust our soil biology and chemistry and achieve better yields if we understand its characteristics.

HUMUS VS. ORGANIC MATTER

We must begin by understanding that there is a difference between soil organic matter and humus. "Humus" is a general term that describes a group of separate but distinct humic substances. "Soil organic matter" is material that is decomposing at various rates in the ground.

Some of the most common substances we collectively refer to as "humus" include:

- Fulvic acid: a yellow to yellow-brown humic substance that is soluble in water under all pH conditions and is of low molecular weight.
- Humic acid: a dark-brown humic substance that is soluble in water only at higher soil pH values and is of greater molecular weight than fulvic acid. Humic acid may remain for centuries in undisturbed soil.
- Humin: a black humic substance that is not soluble in water at any pH, has a high molecular weight, and is never found in base-extracted liquid humic acid products.

Adding a small amount of humus to an acre of soil can achieve positive results.

Applying organic matter is certainly an excellent way to remineralize a soil that has been leached or has no chemical reactions, such as with some sands. Sand with a low cation exchange capacity (CEC) has difficulty holding onto the cations of nutrients, and these cations can easily leach deep into the soil and become unavailable for plant uptake.

Sandy soils are also unable to hold onto water when arid conditions prevail and humus is lacking. Sands reside in a condition of "feast or famine," since water and nutrients are only available for a short time after they are applied. Biomolecules of humus can help retain water and the ionized nutrients that are produced by the natural cycling of organic biomass, compost, or other sources of fertilizer.

The electronegativity factor of humic acids is key in developing and maintaining a healthy and sustainable soil. The source of these humic acids in a sustainable agricultural program, organic certified farm, or urban landscape can be decaying organic matter such as compost. In essence, this is fertilizer in an organic form. It is therefore important to know the ingredient source and the nutrient analysis of your compost.

Humus is powerful stuff, and a tiny amount can produce a huge measurable result. We have seen as little as 40 total pounds on an acre of farmland increase the yield of a crop dramatically.

THE PHYSICS OF HUMIC ACID

Humic acids are extremely important as a medium for transporting nutrients from the soil to the plant because they can hold onto ionized nutrients, preventing them from leaching away. Humic acids are also attracted to the depletion zone of the plant root. When they arrive at the roots, they bring along water and nutrients the plant needs.

long grass and soil

The depletion zone is the area close to the root of a plant from which the root draws (depletes) nutrients. This zone can become particularly depleted if there is a lack of either humic acid or mycorrhizal fungus. When plants are mycorrhizal, the depletion zone is of less importance. Mycorrhizae have hyphae micro-tubes that can extend much further into the soil than the host plant can reach. They can gather mineral nutrition for the benefit of the host plant from outside the depletion zone. Humus is even more critical for plant nutrient availability and uptake if there aren't healthy mycorrhizal relationships in the soil.

Positive ions are more easily absorbed by a plant's root because the root has a negative charge. In other words, the positive (cation) is attracted to negative (the living root). Humic acids hold cations (positive ions) in a way they can be more easily absorbed by a plant's root, improving micronutrient transfer to the plant's circulation system. This works because humic acids (ulmic, humic, and fulvic) pick up positive ions and are then attracted to the root depletion zone and to the hyphae micro-tubes of mycorrhizae.

Since the root's negative charge is greater than humic acid biomolecules' negative charge, scientists theorize that the micronutrients are taken up by the plant's root and are absorbed by the plant's circulation system. Some of the micronutrients are released from the humic acid molecule as they enter the root membrane, but we are now realizing that the plant will also uptake some of the lighter molecular-weight humic acids as well. In essence, the humic substances are chelating such cations as magnesium (Mg2+), calcium (Ca2+), and iron (Fe2+). Through chelation, humic substances increase the availability of these cations to plants.

HOW TO BUILD HUMIC ACID LEVELS

Compost and other sources of decomposing organic matter are not an efficient way to build soil humus levels. Compost rapidly decomposes and leaves its minerals behind, releasing carbon into the atmosphere as CO2. Humic substances, on the other hand, are stable, long-lasting biomolecules. Components of humus have a mean residence time (based on radiocarbon dating, using extracts from non-disturbed soils) of 1,140 to 1,235 years, depending on the molecular weight of the humic acid.

If you really want to fix or rehabilitate a soil, increase its CEC, improve its tilth and porosity, improve water availability for conservation, and therefore make a soil a healthier terrestrial biosphere for all plants, roots, microorganisms, you must depend on humus. Humus is a product of soil chemistry, and is dependent upon a source of its precursor chemicals: amino acids.

Amino acids are the building blocks of protein. The best source of the amino acids in a natural ecotone are produced by the Glomus species of mycorrhizae. These are associated with any grass in a natural, undisturbed site. The tallgrass prairies of the Midwest exemplify this soil-building process better than any ecotone on earth, because grasses utilize a Glomus-mycorrhizal relationship. This is why there is was so much humus-rich topsoil in the Tall Grass Prairies. Glomus makes a soil protein called glomalin, a substance that is rich in amino acids. Combined with humus, they create a huge carbon sequestering and banking factor.

Scientists can measure the percentage of calories in compost that come from proteins (the amino acids), carbohydrates, and fats. This enables them to measure the lack of humus-making potential of compost. Even in supreme-quality compost, the percentage of calories coming from amino acids (protein) is less than 5 percent. Since it is difficult to rely on the perfect amino acid ratio in compost because of differing manufacturing quality controls and ingredient consistency, we cannot predict a 100 percent efficient conversion of all these amino acids into humic substances. Compost or other soil amendments of organic matter are therefore not a reliable way of increasing soil humic substances.

Attempting to add adequate amounts of humic acid through application of compost would require such a huge amount that it could lead to overdosing the site with nutrients. In fact, the better the quality of the compost, the more concentrated the nutrients will be, and the less you should use. In the case of our TTP Supreme Compost, for example, we recommend using it sparingly – never more than 60 pounds per 1,000 square feet or 2,600 pounds per acre. And this is assuming no other fertilizer is being used at the same time.

Humus supplementation is necessary if you want humus. You can measure the quantity of humic acid in a compost product at a qualified lab. A good quality compost will measure around 5 to 8 percent humic acids.

BENEFITS OF HIGH HUMIC ACID LEVELS

One obvious benefit of humus we have seen at our Arboretum in Los Lunas, New Mexico, has been the aggregation of clay. This aggregation has made the clay more porous, soft, and aerobic, with better drainage, resulting in deeper root growth of all plants. The site was purchased in 1986 with clay soil 12 feet deep and a pH ranging from 8.3 to 9.2 – so alkaline that in the winter the site would turn white.

Today we have one of the largest oak species collections of the Quercus genus in the United States, and the largest collection of native oaks of the Chihuahuan Desert Region in North America. Also on the site are several types of redwoods, maples, dogwoods and giant timber bamboo. None of these plants should be able to grow on soils with the conditions we started with, but with the power (or magic) of humic acids we have rehabilitated the soils to a productive and healthy level.

Finally, "Humic Acids: Marvelous Products of Soil Chemistry" (The Journal of Chemical Education, December 2001) states, "Humic acids are remarkable brown to black products of soil chemistry that are essential for healthy and productive soils. They are functionalized molecules that can act as photosensitizers, retain water, bind to clays, act as plant growth stimulants, and scavenge toxic pollutants. No synthetic material can match humic acid's physical and chemical versatility."

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