Humates and Humic Acid

Humate materials: their effects and use as soil amendments
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Humate materials are widely distributed organic carbon containing compounds found in soils, fresh water, and oceans. These substances are formed from the biological and chemical breakdown of animal and plant life, and make up approximately 75 percent of the organic matter that exists in most mineral soils. Humates play a direct role in determining the production potential of a soil.

The importance of organic matter in soil is not a recent discovery. Soil fertility in early agricultural systems was based on the recycling of organic wastes, and the addition of decomposed organic materials improved plant growth. The rise in popularity and use of mineral fertilizers enabled growers to directly supply plant nutrients to the soil, and rapid growth in agricultural productivity occurred. As a consequence, the importance of soil organic matter was somewhat neglected. In Florida, organic matter should be considered as very important due to the sandy nature of the soil. In soils void of significant quantities of clay minerals and organic matter, the addition of humates can have an impact on soil fertility which may be noticeable in the form of improved plant growth.

Effects on Soil Fertility. Native soil humic substances enhance plant growth both directly and indirectly. Physically, they promote good soil structure and increase the water holding capacity of the soil. Biologically, they affect the activities of microorganisms. Chemically, they serve as an adsorption and retention complex for inorganic plant nutrients. Nutritionally, they are sources of nitrogen, phosphorus, and sulfur for plants and microorganisms. All of these effects increase the productivity of the soil.

Commercially-available humic substances added to the soil do not directly contribute significant quantities of nutrients to plants in modern agriculture at the rates normally applied. However, indirect effects of these materials on soil fertility can be significant. Micronutrients, especially iron, may be made more available to plants in the presence of humates. Inorganic iron compounds are very unstable in soil and tend to become insoluble and unavailable, especially in calcareous soils. Humate compounds can incorporate iron into chelated complexes, maintaining its availability to plants, although still in insoluble form.

Soil phosphates are often immobilized through reactions with iron and aluminum, which in turn may be complexed with organic matter. Chelating agents can break the iron or aluminum bonds between the phosphate and organic matter, releasing phosphate ions into solution. This dissolution is a process which occurs in soil in the presence of naturally-occurring humic substances or plant root exudates. The addition of humates may increase the rate of this process, thereby increasing the availability of phosphorus to plants.

Applied pesticides substantially interact with soil humic substances, but the reactions are complex. Some pesticides may be immobilized by humates and can practically disappear from the soil environment. In this case, humic substances can be very effective in removing excess pesticide from sandy soils very low in organic matter. The most common reaction between pesticides and humates is adsorption, followed by a release to the soil solution at a rate dependent on the chemical structure of the pesticide. Degradation of the pesticide will be determined in part by the rate of release. Humic substances may be used in this case to control the concentration of pesticide in the soil solution, and to avoid toxicity hazards. A third case involves the mobility of pesticides by humic material. Some groups of compounds can form complexes with humates, which can then be absorbed by plant roots.

Effects on Plants. Humic acids can have a direct positive effect on plant growth in a number of ways. They have been shown to stimulate seed germination of several varieties of crops. Both plant root and top growth have been stimulated by humates, but the effect is usually more prominent in the roots. A proliferation in root growth, resulting in an increased efficiency of the root system, is a likely cause of higher plant yields seen in response to humic acid treatment.
Humic matter has been shown to increase the uptake of nitrogen by plants, and to increase soil nitrogen utilization efficiency. It can also enhance the uptake of potassium, calcium, magnesium and phosphorus. Chlorosis in plants has been prevented or corrected by humate application, probably the result of the ability of humate to hold soil iron in a form which can be assimilated. This phenomenon can be particularly effective in alkaline, calcareous soils, which are normally deficient in available iron and low in organic matter content.

Effect of Management Practices on Soil Organic Matter. Cultivation of soils usually causes a decrease in the organic matter content. Rather than being completely destroyed, the organic matter in the soil tends to reach a new, lower equilibrium level. For most soils, a high level of organic matter is maintained only by grass species. Grass middles between citrus tree rows can help maintain higher organic matter in the portion of the citrus tree root zone that extends into them. However, the establishment of clean herbicide bands within three rows to facilitate harvesting and other operations may decrease the organic matter content in what is normally the major area of tree root concentration and fertilizer application.
Conventional sources of applied organic matter such as farm manures or crop residues are not normally used in a citrus grove situation due to lack of availability or prohibitive cost. The leaf and dead wood litter that is generated is not sufficient to maintain an organic matter content under the trees which is comparable to that under grass middles. Efforts to increase citrus grove soil organic matter content have been made by growing cover crops using species of *Crotalaria* or hairy indigo, but success was poor because the crops could not be sufficiently incorporated into the soil without damaging the tree root system.

Non-conventional Sources of Organic Matter: Humic substances. Humate products for agricultural use are produced through mineral sand mining and recovery operations. The end product contains a majority of organic material (concentrated humic acid) mixed with smaller amounts of mineral matter. It can be applied to soil to improve its fertility, especially in the zone of highest root activity. Humate concentrates provide many of the advantages of conventional organic matter sources over a long period with less handling problems, especially in situations where there is no feasible alternative to purchasing additional supplies of humus. They have been demonstrated to have favorable effects on tissue nutrient balance, fertilizer uptake, top and root growth, and crop yield and quality for a large variety of field, horticultural and ornamental plants. They have been most effective in soils with less than two percent organic matter.
The plant characteristic that the addition of humic substances has consistently enhanced more than any other is root length, especially on sandy soils. A preliminary study with the citrus trees potted in sand showed that after a period of one year, the root dry weight was increased when a humic acid material was added at the rate of one lb. per cubic yard of soil as compared to an untreated treatment. Tree top

growth, vigor, and trunk cross-sectional area also increased in response to humate addition.
A field study with young citrus trees is currently underway to determine if the addition of humic acid can increase fruit yield. In this trial, the trunk cross-sectional area increase of newly-planted trees was greater for the first year of growth where 0.5-1.0 lb. of humate material per tree was applied at planting. These data are not conclusive, as much more research is needed to determine the long-term effects of humic acid addition to citrus trees, especially as they come into bearing.

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