NuHumic WDG

featuring verge granular technology

PRODUCT INFORMATION BULLETIN

NuHumic WDG is a technically woven, humic acid-based soil conditioner that combines humic acids with VERGE™, a leading edge dispersing granule. NuHumic WDG's novel granule complex introduces a new dimension to humic acid products – providing a reliable source of unparalleled levels of soluble humic acid to the plant rootzone without having to rely on inconsistent geochemical or microbial reactions to breakdown parent materials (such as Leonardite fines) used in many other humic acid granule products.

Humic substances (HS) are a source of concentrated organic matter. They are known to be among the most biochemically active molecules found in soil. They are recognized for both their beneficial effects in soils (particularly in soils deficient in organic matter) and their influence on the growth and cultivation of plants. They impart a significant influence on the overall quality and productivity of the soil.

Humic substances are long-lasting critical components of natural soil systems. They can remain in soil systems for centuries or even millenniums. However, it is estimated they can also be destroyed in less than 50 years by some agricultural practices. Or they may exist in very limited amounts in "constructed" soil systems such as found in today's golf course greens and tees.

Humic substances (HSs) are a series of relatively high-molecular-weight, light-brown- to black-colored, complex and heterogeneous organic polymers formed by secondary synthesis reactions (Stevenson 1982).

These substances are partitioned into three main fractions based on their solubilities in alkaline and acidic extraction solutions. These are *humic acids* (HAs), which comprise the alkali-soluble but acid-insoluble fraction; *fulvic acids* (FAs), the fraction soluble in both alkali and acid; and the *humin* fraction, which cannot be extracted by either dilute base or acid (Stevenson 1982; Schnitzer 1982).

The term, "Humic acid," is often used commercially as a general term for humic substances (HS) that contain humic and fulvic acid fractions. Humic substances are formed in what can be described as an complex "open" system where an infinite number of plant materials are available and where an equally infinite number of chemical functional groups can be formed. The variables are so extensive that no two humic acids are the same.

Nature's Chameleon

Humic substances have been described as being constructed with chameleon-like molecules, that will adopt conformational changes in order to facilitate their adsorption to the soil particle interface or even as surrounding conditions change.

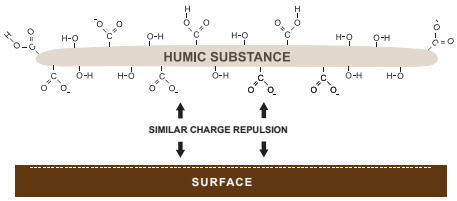
Any change in solution pH, concentration or the presence of metal ions — especially calcium ions — will cause huge changes in the physical makeup of the humic molecules. Even slight changes can cause the molecules to change in orders of magnitude.

Conformational Changes

Humic substances are usually present as negatively charged polymers (due to the presence of weak acid functional groups such as carboxylic acid, –COOH). In water, both non-polar and anionic (negative charge) forms exist in an equilibrium.

$$R–COOH <=> R–COO^- + H^+$$

Theoretically humic substances should be repelled from the sand particle surface which also has a negative charge.



However, humic substances will undergo changes to their molecular configuration to overcome this similar charge repellency at the soil interface.

Scientists have found humic substances commonly initiate adsorption to the sand particle surface through segment-surface bonds such as:

- Cationic bridges
- Association with hydrous oxides
- Hydrogen bonds

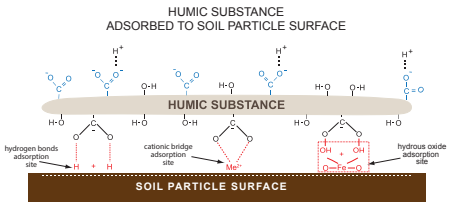
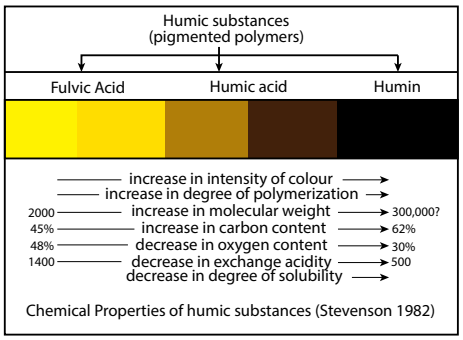


Illustration depicting HA forming segment-surface bond to promote attraction to soil surface

These bonds effectively reverse the surface charge of humic substance adhesion points to positive values that allows them to adsorb to particle surfaces through electrostatic interactions. Once segment-surface bonds are formed, temporary induced polarity of non-polar sites on organic substances (via van der Waals' forces) also contribute to adsorption.

Humic Acids and Fulvic Acids

Most investigators agree that differences between humic acids and fulvic acids, can be explained by variations in intensity of color, carbon content, molecular weight, numbers of functional groups (carboxyl, phenolic OH), solubility characteristics and extent of polymerization.

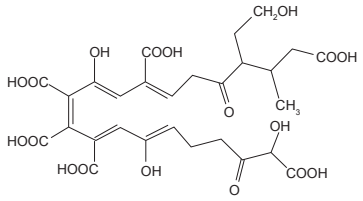


Chemical Properties of humic substances (Stevenson 1982)

Fulvic Acid

Fulvic acid is the lowest molecular weight fraction of humic substances. By definition it will be golden in color.

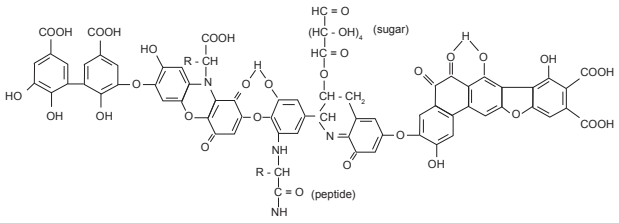
Because of its small molecular size, fulvic acid is able to penetrate the leaf and even the mitochondria of a cell which makes it great for foliar sprays and root drenches.



Fulvic Acid according to Buffle et al. (1977)

Humic Acid

Humic acid is one of the most important components of HS. Humic acid has a larger, more complex molecular structure than fulvic acid.



Model structure of humic acid (Stevenson 1982)

Humic acid components are low molecular weight compounds but they aggregate step by step resulting in higher molecular weight aggregates and supramolecules of higher molecular weight capable of self-assembly, folding, and dynamic covalent chemistry. By definition it will be brown to nearly black in color.

Features

Humic acids provide a concentrated form of organic matter that can enrich areas of turfgrass soils that are deficient in organic matter. The array of charged functional groups (both negative and positive) on the humic molecule make them extremely versatile and offer managers of agronomic systems a number of features and benefits.

Improved Soil Conditions

Increased Cation Exchange Capacity. Negative and positive sites on humic substance fractions attract and retain cations in the soil, resulting in increasing soil CEC. Once complexed with humic substances, nutritional minerals are retained in the soil rootzone longer and reduce their tendency to leach – improving the nutritional value of the soil rootzone.

Since humic acids also have positive sites on their molecules, negatively charged anions such as phosphorus and nitrates are also held and their loss due to leaching is reduced.

Nitrogen Management. The ability of humic substances to enhance the fertility of soils and stabilize nitrogen in the soil profile is well established.

Humic substances applied to soils can be used to prevent nitrogen leaching – particularly on sandy soils and on sand-based areas of golf courses.

Improvement of nitrogen utilization and overall turfgrass quality should be expected as well as improved efficiency of applied fertilizers

Soil Organisms. Humic substances are a good source of carbon for beneficial soil organisms. Humic substances and non humic (organic) compounds provide the energy and many of the mineral requirements for soil microorganisms and soil animals.

Soil Structure. As humic substances become intimately associated with the mineral fraction of the soil, complexes of humus-clay and humus silt aggregates are formed. Since humic substances exhibit positive sites on their molecules as well as negative sites, HS can effectively serve to promote the attraction of fine soil particles and clays that result in aggregation. These aggregates impart desirable "friability" characteristics such as good crumb structure, improved tilth and air : water ratios.

Buffering agents. Humic substances have been shown to buffer (neutralize) the soil pH and liberate carbon dioxide. Both acidic and alkaline soils can be neutralized. Once the soil is neutralized, many trace elements formerly bound in the soil and unavailable to plant roots, because of alkaline or acidic conditions, become available to the plant roots.

Water Holding Capacity. Water consists of a polar molecule and its positive hydrogen atoms are attracted to the negative sites on the humic molecule. Adsorption by water on the humic substance is similar to what happens on soil surfaces and the overall effect is to increase water holding capacity in the soil. It is particularly beneficial to sandy soil profiles where there are fewer negative sites for water adsorption.

Rootzones with adequate humic acid content also demonstrate improved water infiltration, air : water ratios and uniform water distribution.

Toxic substances. Degradation or inactivation of toxic substances is mediated by humic substances. Humic substances have charged sites on their surfaces which function to attract and inactivate pesticides and other toxic substances. Soil humic substances are capable of either stabilizing or assisting in the degradation of toxic substances.

In Planta Features

A small fraction of lower molecular weight components in humic substances can be taken up by plants. The stimulatory effects of humic substances has been correlated with enhanced uptake of macronutrients. Studies of the effects of humic substances on plant growth show positive effects on plant biomass.

There appears to be a close correlation of humic acids and fulvic acids with increases in the permeability and facilitation of mineral elements movement through the cell membranes.

Humic substances also have a very pronounced influence on the growth of plant roots. Root growth is generally more apparent than stimulation of shoot growth.

Humic Acids – A Strong Value Proposition for Sustainable Turfgrass Management

Humic substances not only impact the physical, chemical and biological properties of soils, they also have a direct influence on turfgrass. Their use continues to escalate as they continue to demonstrate economical and ecologically friendly solutions for sustainable turfgrass management practices - especially in soils with depleted levels of organic matter.

While a number of sources can be considered as raw material for the manufacture of HA-based soil conditioners, Leonardite (an oxidized lignite coal containing up to 85% humic acids) is generally preferred (particularly for soil applications).

In order to be soluble, humates in raw form such as lignite or leonardite must go through an alkaline extraction process. Potassium hydroxide-based extraction is usually favored as it removes more soluble humic acid substances from the raw Leonardite material. Once they have been extracted and concentrated they become soluble in water. By comparison, raw humates can take much longer to break down and become plant available.

Problem Area - Source of HA

The source material for humic acids is quite important. Yet the marketplace presents superintendents with numerous products containing a variety of HA source materials.

The vagaries of selecting soil conditioners contain humic acids continues since source materials are one thing, but the amount of soluble humic substances released from carriers into the soil profile is yet another.

For example, two manufacturers may source the same high quality raw Leonardite material containing 85% humic acids. But each product manufacturer may (and often do) choose to extract the soluble fractions (humic and fulvic acid) using proprietary methods that result in different percentages of soluble extracted humic acids. Still others may choose to use a combination of raw material with extracts.

It should be noted that unless HAs are soluble, they are inactive in soils and unavailable to plants. **So regardless of the stated source material and humic acid content, the key consideration is the percent of soluble humic acids released from the soil conditioner in the soil.**

Now consider that each manufacturer is using their own granular material -- each of which is capable of loading a different amount of active ingredient on the carrier and each has its own release characteristics.

Since specific standards for products containing humic substances are not yet universally established for registration purposes, superintendents should feel free to investigate and ask questions regrding any product's source materials and percent of humic acids released in the soil before making a decision.

Problem Area - Granular Formulations

Many formulations are dusty and are composed of granules with uneven size, making them almost impossible to handle. Variable granule sizes also adversely affect the physical distribution of the dry materials, resulting in applications with non-uniform disbursement of the humic acid active ingredients within the rootzone.

There is also reported problems with the uncertainty associated with products that must rely on microbial activity to convert the raw parent material to soluble humic fractions. There is always a degree of uncertainty associated with biological release of active ingredients.

Today dispersible dry granular humic soil conditioner formulations have come a long way towards addressing dust issues non-uniform granule size. Issues dealing with both the uniformity of active ingredient dispersion and the actual levels of soluble humic acid following application remain with some formulations.

NuHumic WDG
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With the introduction of NuHumic WDG, innovative concepts and leading edge technologies are moved to reality. More importantly, the use of NuHumic WDG allows the turfgrass manager to profit from a product that redefines humic acid performance.

NuHumic WDG humic acid fractions improve the soil structure and enrich the properties of soil by increasing the exchange capacity and buffering qualities, increasing the retention of applied fertilizers in the soil profile, promoting the chelation of many elements and improving their plant uptake.

Source of HA

Only Leonardite containing high percentages of humic acid is used in the production of NuHumic WDG.

NuHumic does not rely on the uncertainties associated with the need for precursors, biochemical reactions and enhanced microbial populations to solubilize its humic acids.

Granular Formulations

NuHumic WDG granules are a novel source of soluble bioactive components of high quality humates.

The NuHumic WDG granules incorporate a patented clay and leonardite complex within the proprietary Verge dispersing granule's composition.

verge™

Verge is the product of advanced processing techniques and a natural raw material that are combined to create innovative granules with unsurpassed function, uniformity and appearance.

Improved handling and reduced dust exposure

Verge has a durable outer core and spherical shape that prevents tiny fragments from breaking off, unlike traditional, irregular-shaped granules that rub together during handling, transportation, and formulation.

Superintendents using NuHumic WDG with Verge technology should experience a formulated product with improved handling and reduced dust exposure.

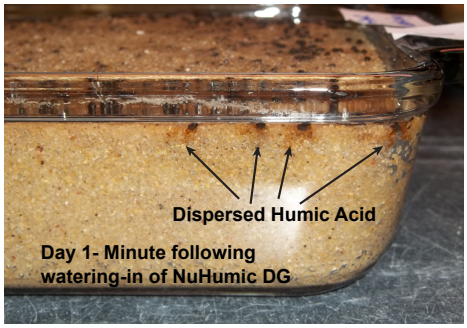
Uniform distribution of granules and active ingredient

Application tests using a rotary spreader show that Verge granules are more evenly distributed across the swath width regardless of distance from the spreader.

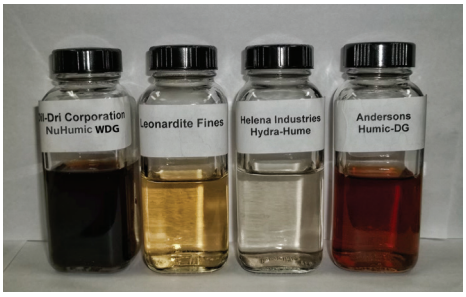
This results in a uniform distribution of granules and active ingredient across the treatment area.

Rapid Release HA Delivery System

The NuHumic WDG Verge granule has been engineered to rapidly release its high humic acid content following a watering-in cycle.

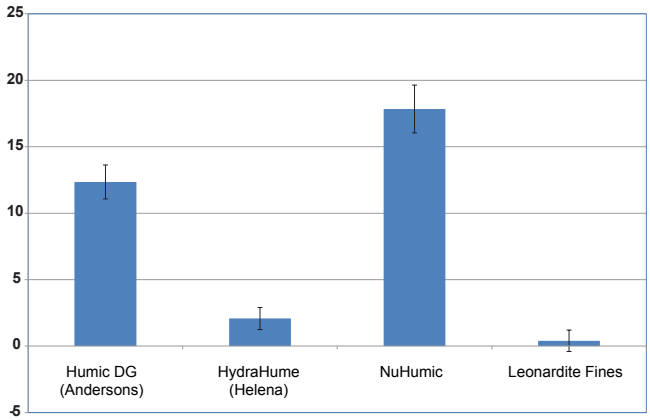


Levels of humic acids sufficient to initiate reactions needed to improve the soil structure, enrich the properties of soil and provide benefits to plants are quickly established with the use of NuHumic WDG.



Darker brown color of NuHumic WDG sample indicates a higher percentage of soluble humic acids in water extract.

Percent Humic Acid Released in Water



Results of water extraction test. Results determined using modified version of the California Method for Determining Humic Acid.

NuHumic and fertilizers

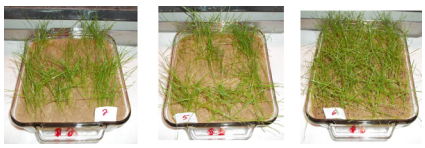
NuHumic WDG is well suited for use with dry fertilizers. When moistened, the NuHumic WDG granules quickly dissolve to release their soluble humic acids. The dispersed humic acids surround the fertilizer particles.

Microbes are attracted to the HA carbon source "coating" and the fertilizer is digested by these microbial colonies.

This biochemical process promotes the retention of the fertilizer in the root zone so that leaching is minimized.

Humic acid chelation of fertilizer and trace elements also markedly increases plant uptake thereby providing more nutrients to the plant and a better yield.

Test Results
Rye Grass
Study #1
21 Days Following Application



FERTILIZER ONLY

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NuHumic WDG
featuring verge granular technology

Redefining Humic Acid Performance

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