Improving Soil and Plant Performance

A White Paper for Crop Producers, Retailers, Custom Applicators and Crop Consultants
SUMMARY

What are Humic Substances?

Humic Substances can be broadly defined as: “Highly abundant organic compounds formed in soils and sediments by the decay of dead plants, microbes and animals” (Tipping, 2002); they are widely perceived to be a major component of soil organic matter.

In the context of production agriculture, humic substances have long been attributed with improving soil productivity (Nardi, Pizzeghello, Muscolo & Vianello, 2002).

Benefits: Plant Biomass and Increased Nutrient Absorption

The benefits of humic substances on plant growth and soil productivity has been most commonly attributed to increased fertilizer efficiency, improving soil chemical and biological conditions, biostimulatory effect on plants, and in the reduction of soil compaction as well as in a direct improvement of overall plant biomass by an increased absorption of nutrients by plants.

These “increased nutrient acquisition” type roles have long been attributed to the complexing properties of humic substances which can increase the availability of nutrients (Nardi, Pizzeghello, Muscolo & Vianello, 2002).

"My growers always see these three things and that’s why they use the Actagro line:
1. The release of nutrients tied up in the soil.
2. The buffering of salts.
3. The ability to add carbon to the soil and increased water holding capacity."

Brian Rehor – Retailer, Colorado
FIRST, SOME BACKGROUND…

Understanding Humic Substances – An Academic* Introduction

*this is for those that want to know all the details, if you are a “just the facts” type of person, skip ahead to the benefits

Humic substances, often defined as organic compounds – are the result of the complete microbial metabolism of plant and animal matter by geological forces (i.e. pressure, heat) over an extended period of time.

This is a process known as “humification”. Humic substances are biologically refractory but chemically reactive super mixtures (see Figure 1) that can be extracted from soils, sediments, peat, mineraloids (leonardite) or aquatic sources (Rezai, 2013).

Generally speaking, humic substances can be categorized into Humic and Fulvic Acid and Humin Components. Humic Acid is acid insoluble and often characterized by a molecular weight in the 20,000 to 50,000 average. It is considered to be a colloidal substance/composed of micellar aggregates of smaller molecules (1,000 - 2,000 avg. mw).

By contrast, Fulvic Acid is considered acid/base soluble and not likely to aggregate into larger conglomerations (averaging 1,000 in mw). Finally, Humin which is acid/base insoluble is characterized as being up to 300,000 in mw and comprised of humic acid, a mineral component and a lipid component (Sutton & Sposito, 2005). It should be noted that, albeit convenient, identifying or defining humic substances by this categorization is not at all simple since by some assertions their chemical structure has never been completely defined and newer thinking is that even the large molecular fractions are aggregates smaller molecules.

In fact, humic substances are composed of complex mixtures with abundant phenolic, carboxyl, and hydroxyl functional groups, Figure 2. Some would go as far as to suggest that no two molecules of humus are alike.

SO WHAT?
WHY IS THIS IMPORTANT TO FARMING TODAY?

The Benefits of Humic Substances in Agriculture

Simply put, it has long been recognized by the agriculture industry (and increasingly more so in recent years) that humic substances can play a significant role in influencing soil productivity.
Humic substances can improve the soil’s physical properties and moisture conditions as well as provide a high cation exchange capacity crucial in soil fertility dynamics (Pena-Mendez, Havel & Patocka, 2005).

For production agriculture specifically, humic substances have been shown to improve physical, chemical and biological soil conditions. Humic materials are well known to improve cation exchange capacity in the soil; nutrients which might normally be fixed or leached out in specific pH ranges are instead maintained through complexation with organic compounds such as humic substances (Mikkelsen, 2005). This potential ability to enhance nutrient solubility and availability proves to be invaluable to agricultural operations resulting in improved quality of crop and increased yields. Biological benefits of humic substances are not to be dismissed, as stimulatory plant responses following applications of humic materials have also been well documented (Mikkelsen, 2005).

**SOIL HEALTH: NUTRIENT AVAILABILITY, WATER HOLDING CAPACITY AND MORE!**

Among the observed benefits of humic materials are increased CEC, nutrient availability, metal complexation, auxin-like effects, water holding capacity and membrane permeability of nutrients, and salt mitigation (Rezai, 2013).

**HOW ACTAGRO HAS CRACKED THE CODE**

**Not all Humic Based Products are Created Equal: The Actagro Organic Acids® Technology Platform™**

Across a broad range of soil types, soils treated with Actagro Organic Acids are highly valued for their ability to produce high crop yields through improved soil ecosystems and increased nutrient use efficiency.

Actagro is committed to the delivery of new agronomic tools for production agriculture to restore soil health and maximize plant productivity through agronomically sound crop programs resulting in higher yields and improved crop quality. Actagro products leverage the complexity of proprietary extractions of organic matter to provide an optimized nutrition delivery system via the Actagro Organic Acids® Technology Platform™.

**PROVEN TO REPLENISH THE SOIL**

They are proven to replenish the soil via multiple mechanisms as well as maximize plant activity. They are research proven to:

**Maximize Nutrient Availability By:**
- Increasing CEC in the application zone
- Increasing availability and solubility of nutrients

**Reducing the negative effect of variable pH**

**Moderate Toxicity of Salts By:**
- Complexing fertilizer salts reducing root and leaf burn

**Improve Plant and Microbial Activity By:**
- Providing food sources for beneficial microbes
- Encouraging greater root mass and plant vigor

**WHAT’S BETTER ABOUT ACTAGRO PRODUCTS?**

Unlike simple humic substances, the finished chemistries in Actagro products have been optimized for agronomic performance and are far more comprehensive, maximizing access to the least soluble yet most beneficial component of organic matter (Humin) as well as to proprietary carbohydrate packages. Complex chemistry shows Actagro products’ unique and differentiated chemical composition when compared to standard humic acids (Rezai, 2013).

Through its extensive research and discovery chemistry investment, Actagro has developed a variety of solutions for growers interested in maximizing their operations inclusive of: High Efficiency Fertilizers Solutions (nutrients complexed and reacted together with Actagro Organic Acids), Plant Stimulant Solutions, Organic Solutions, Nutrient Management Solutions and Soil Health Solutions (Actagro Liquid Humus®).

**Better than soil amending products**

It should also be noted that Actagro products are proven to surpass simple humic blends. They deliver novel chemistries through chemical synthesis using naturally sustainable materials resulting in highly efficient nutrients.
via the soil or through foliar applications. They also surpass simple soil amending products. They provide extracted natural organics combined in formulations to represent soil stable humus resulting in a healthy, productive soil ecosystem and environment for root and plant stimulation.

ACTAGRO LIQUID HUMUS: WHAT DOES THE RESEARCH SAY?

Key Benefits Confirmed

Actagro Liquid Humus® is a soil and plant accelerator ideal for growers interested in higher CEC, water retention, fertilizer enhancement and overall improved soil biology and plant health resulting in increased yield, quality and return on investment.

The technology in Actagro Liquid Humus makes it the only product on the market able to provide both a humin component and a carbohydrate package in addition to humic and fulvic acids.

Actagro Liquid Humus can be applied as a soil or foliar product and is specifically manufactured to help growers increase their soil and plant productivity.

KEY STUDY

By Dr. Husein Ajwa University of California, Davis

Water holding capacity improved 10%

In a study conducted by Dr. Husein Ajwa of UC Davis, Actagro Liquid Humus was tested in a variety of soil types for its water holding capacity influence. Data showed Actagro Liquid Humus to improve water holding capacity by as much as 10%.

Need the Proof? Detailed Results:

The sandy loam soil used in this study typically holds an average of 1.25” available water per foot. Actagro Liquid Humus increased that by 4 - 10% or 0.05 - 0.125” of water (Figure 3). This translates to (assuming Actagro Liquid Humus is well mixed into 1 foot of soil) a delay in the need for irrigation by as much as a day or 2 early in the season. In the clay loam soil tested, (which typically holds an average 1.9” available water per foot) Actagro Liquid Humus increased capacity by 4 - 10% or 0.08 - 0.19” of water. (Figure 4). In this case, irrigation could be delayed by as much as 2 or 3 days early in the season.

Study Methodology:

The study was conducted by applying different concentrations of Actagro Liquid Humus to samples of dry soil.

Once the product and soil were mixed and dried, samples were then mixed and dried again. A lab followed up to test water holding capacity with the following, standard, water holding capacity measurement test using a pressure plate:

“Determines the soil moisture content under constant preset pressure potential (0.3 atm and 15 atm). Soil is brought to near saturation and then is allowed to equilibrate under a either 0.3 or 15 atmospheric pressure potential. The method is used to determine the available water capacity of soils and/or moisture release curve. The method detection limit is 0.5%” (Klute, 1986).
30% MORE WATER RETAINED

Further studies conducted by Actagro, suggest that Actagro Liquid Humus can also impact water evaporation. Actagro Liquid Humus was diluted with tap water to mimic field application rate of 4 gal/acre in a total volume of water equal to 5000 gal/acre. A sandy loam soil was homogenized and dried in the laboratory hood for three days. Actagro Liquid Humus solutions were added to soil samples at a proportional ratio of mL/cm² that matched gal/acre. Soil samples were weighed after application of solutions and left on the bench (70 - 80°F). Samples were then weighed daily and water loss over time was measured and graphed.

Need the Proof? Detailed Results:

After 14 days, soil samples applied with Actagro Liquid Humus solutions retained 30% more weight than the control (Water Only). Assuming the majority weight loss is water, Actagro Liquid Humus solutions show a marked improvement in soil water retention under the laboratory conditions tested.

LOWERED SOIL SALINITY

Need the Proof? Detailed Results:

In a study conducted by Actagro’s Research and Development team Actagro Liquid Humus was tested in a trial measuring its impact on soil salinity. Treatments were as follows:

- Untreated Control
- Actagro Liquid Humus at 2 gpa (banded down to 2, 3” wide bands/bed) at about 15% of soil surface wide bands.

Treatments were applied in a commercial head lettuce field (40" centers) on soil surface post-planting. Irrigated via sprinklers for the first 4 weeks and then moved to single line subsurface drip. Soil samples were taken at 0 - 5” and 5 - 10” on the day of sampling (pre-application) and then again on day 21, 42 and 63 post application. The EC for the irrigation water in question, was approximately 2.6 ds/m. Research associates followed the crop through to harvest where the lettuce from each plot was weighed (for biomass) as crews cut and boxed it.

The soil salinity at the beginning of the study was recorded at ECE 4 - 4.5 ds/m. Actagro Liquid Humus at 2 gpa lowered soil salinity at 5 - 10” by 45% at 9 weeks post application (Figure 5). SAR, soluble Na and Cl were all reduced as well.

![Figure 5](image_url)
This study was conducted by Actagro scientist to determine the efficacy of Actagro Liquid Humus on salt buffering and water relations as well as on early growth stimulation, overall growth, yield and yield components such as: ear size and kernel rows in sweet corn in comparison to competing humic substances.

Various products, testing some of the market’s competing products, were applied post plant/pre-emergence. A site was selected in a commercial sweet corn field located in Fresno County, California. The study showed Actagro Liquid Humus to be the most effective among its competitors by increasing yields, overall weight and average kernel rows per ear.

The Actagro Liquid Humus treatments at 2 and 1 gallons per acre respectively, were the best post planting treatments. Ear weight, stalk and total weights as well as shucked ear weight, average weight per ear and average number of kernel rows per ear were highest with Actagro Liquid Humus® (Figures 6 and 7). Simply stated, no competing material performed as well as Actagro Liquid Humus in all measured parameters. Clearly, there is a difference in “humus type” materials. Unlike its competitors, Actagro Liquid Humus appears to have stimulant activity early, as well as enough staying power to finish with stronger results. Additionally, less Actagro Liquid Humus (Figures 6 and 7) accomplishes more than its competitors, supporting claims of its increased efficiency.
“After using the Actagro Organic Acids technology, especially Actagro Liquid Humus, over the past three years we’ve noticed a big difference in overall tree health. Our Texas citrus growing environment is very difficult with calcareous soils, salty water, extreme temperatures and flood irrigation. The Actagro Liquid Humus helps our trees deal with the many different stresses that can happen within the growing season. We will continue to run the Actagro Liquid Humus with our soil applied fertilizer applications moving forward.”

James Bettiga, Grower
MORE BACKGROUND: ABOUT ACTAGRO

Actagro® is premier developer, manufacturer, and marketer of environmentally sustainable soil and plant health technology solutions that enhance value for our customers globally.

As a science-based technology provider, we deliver a broad range of highly effective solutions via our proprietary Actagro Organic Acids and Nutri-Guard Technology Platforms™.

For over 35 years Actagro has maintained the commitment to develop and expand its technology, which has proven to be consistently successful. Actagro is by far the leader in research of product performance, and Actagro's staff stand as the industry's experts in organic acid technology. Actagro is committed to helping production agriculture achieve higher, more cost-effective crop yields through agronomically sound soil and plant health programs.
REFERENCES


Nardi, Pizzeghello, Muscolo, and Vianello (2002). Physiological effects of humic substances on higher plants. Soil Biology & Biochemistry, pp. 1537-1536


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