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# Role of Humic Substances on Soil Health and Crop

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***Abstract***

In recent years, extensive research has been conducted to enhance both the quality and quantity of agricultural production. While, mechanization and the development of hybrid seeds have significantly contributed to agricultural progress, soil health remains a crucial factor. Soils deficient in organic matter often prove unsuitable for plant growth. To address this challenge and improve crop yields, humic substances are increasingly being incorporated into soils across various regions. Today, humic substances is commercially available in several forms such as powder, granules, liquid, and flakes and can be applied using different methods, including soil application, foliar spray, seed treatment, root dipping, drip irrigation, or in combination with chemical fertilizers. To know the optimum dose of the humic substances, various studies were conducted on crops and discovered a positive response in yield attributed to character, yield, and soil properties. This review enlightens the relevance of humic substances on different crops and soil health, and boosts agricultural productivity.

## Introduction

Soil organic matter is the fraction of the soil that consists of plant and animal tissue in various stages of breakdown (decomposition). Most of our productive agricultural soils have between 3 to 6 % organic matter. Organic matter is made up of plant tissue and animal manures. Humic substances (HS) are remains of decomposed plant and animal materials such as lignin, tannins, cellulose, and cutins (Tan *et al.,* 2000; Billingham, 2012; Hayes and Swift, 2020). HS are classified as humic acids (HA), fulvic acids (FA), and humins based on their solubility in water, acidic or alkaline solutions (De Melo *et al.,* 2016). Humic substances are an extremely important soil component because they constitute a stable fraction of carbon, thus regulating the carbon cycle and the release of nutrients, including nitrogen, Phosphorus and sulphur. Additionally, the presence of humic substances improves water holding capacity, pH buffering and thermal insulation (Stevenson, 1994 and Ayuso *et al*., 1996). Humic acid increase soil nutrients availability, especially micronutrients by chelating and co-transporting micronutrients to plants (Yang *et al*., 2021); reduce the transportation of toxic heavy metals

by precipitating them, thus reducing toxic heavy metals intake by plants (Wu *et al*., 2017). Humic acids also increase crop growth by increasing plant growth promoting hormones such as auxin and cytokinin, which aid in stress resistance, nutrients metabolism, and photosynthesis (Billingham, 2012). Humic substances also improve plant nutrient uptake, plant root growth and plant water retention.

**Composition of Humic Substances:**

Humic substances are complex organic compounds composed of:

- **Carbon:** Main structural element
- **Hydrogen:** Forms functional groups
- **Oxygen:** Forms functional groups like carboxyl and hydroxyl
- **Nitrogen:** Present in smaller amounts, influencing properties
- **Sulphur:** May be present, affecting reactivity

**Functional Groups- Carboxyl (-COOH):**

**- Hydroxyl (-OH):** Involved in hydrogen bonding and reactivity

**- Phenolic:** Influences reactivity and antioxidant properties

**Classification of humic substances are typically classified into three main fractions:**

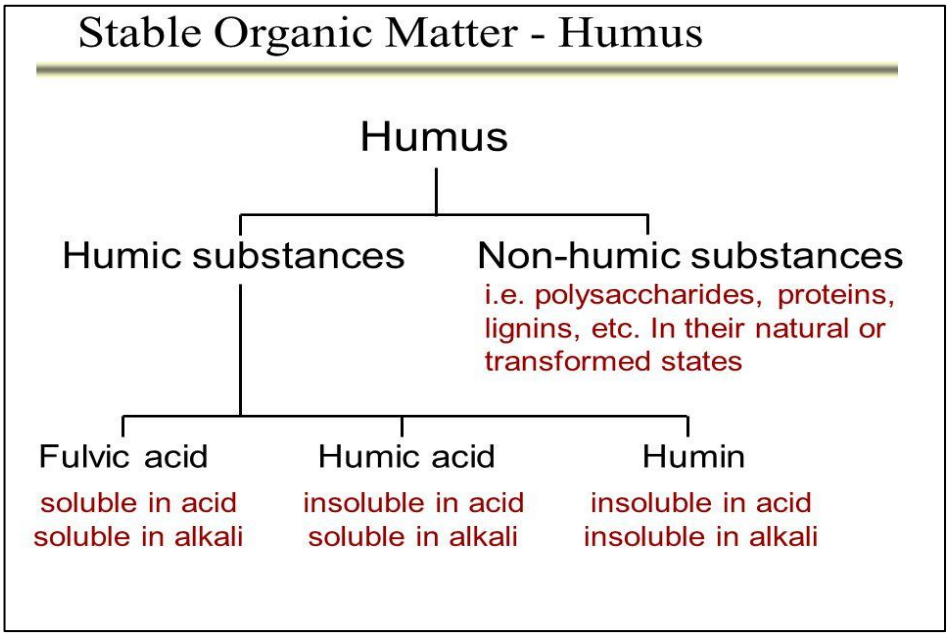


**Fig 1. Classification of Humic substances**

**Extraction of Humic Substances:**

Extraction of humic substances from organic matter present in soil is based on their solubility in water in acidic and alkaline condition. Commonly used method is treatment with alkali; dilute NaOH and $Na_2CO_3$. Treatment with alkali converts insoluble polyvalent cation humates and mineral humates to soluble sodium humates. If soil is high in Ca or $CaCO_3$; it is

treatment with HCL prior to alkali treatment.

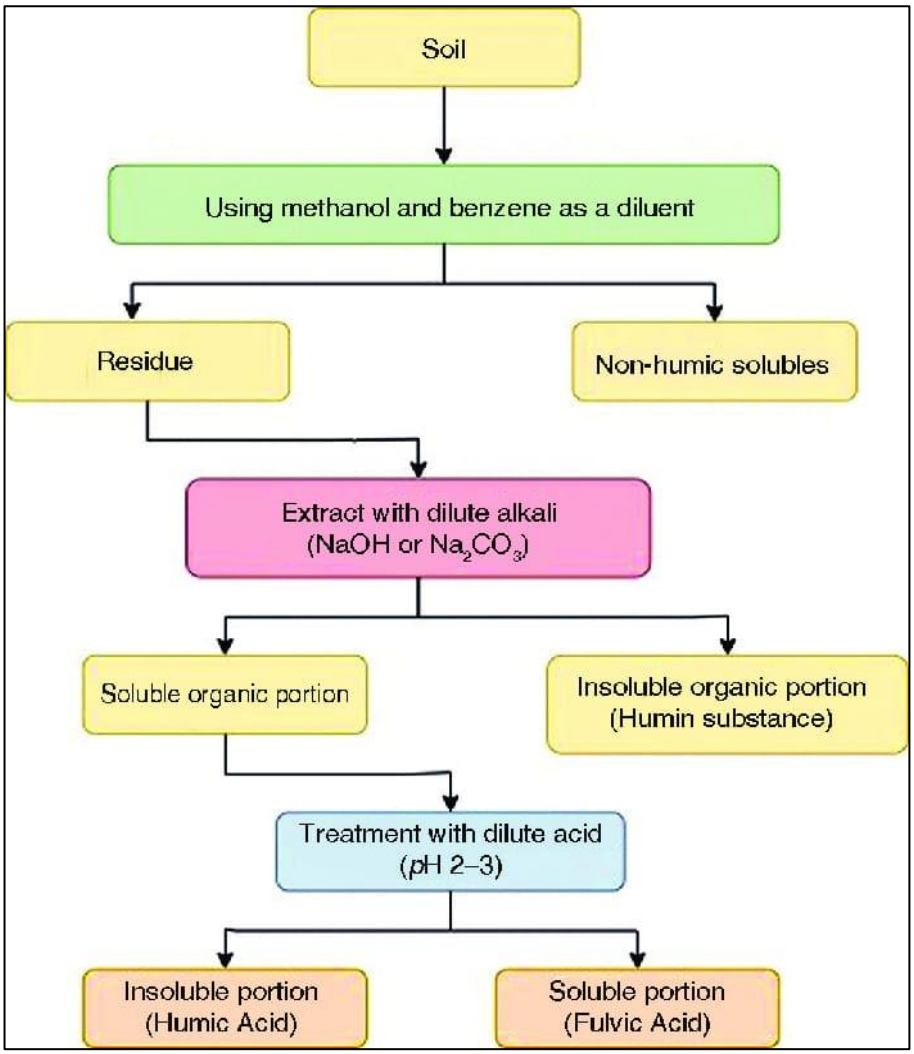


**Fig 2. Scheme for extraction and fractionation of humic substances**

**(Source: Biswas and Mukherjee, 1994)**

**Chemical nature of Humic Substances:**

- Humic substances are polymeric compounds, builts up mainly of aromatic units.
- Aliphatic structure (Fatty acids, etc.) are also present as branches on the chain.
- Major functional groups in humic substances are carboxyl, phenolic hydroxyl, amino, quinone, ketone, etc.
- HS have a high molecular weight.
- Humic substances have a negative charge, allowing them to interact with positively charged ions and molecules.
- Humic substances are heterogeneous mixtures of compounds, making their chemical nature complex and dynamic.

**Humic substances and their influence on soil Health**

Humic acids are organic compounds that play crucial roles in enhancing the qualities of soil, the growth of plants, and other agronomic factors. According to the research that was conducted, HA has the potential to have a beneficial effect on the soil's physical, chemical, and biological properties. These properties include the aggregation and relative proportion of soil particles, the capacity of soil to hold water, cation exchange capacity (CEC), pH, carbon content in the soil, enzymes activity, macronutrients cycling, and availability (Ampong *et al.* 2022). Humic acid contains many compounds, including macromolecule, hydrophobic, hydrophilic, and functional groups. The hydrophilic nature of humic acid attracts the hydrogen ions that lead to increased water holding capacity of the soil. Organic humus contains humic acid (HA), which has the potential to have a significant impact on soil health and plant development. Also, it helps to improve the soil's structure and water storage capacity (Fahramand *et al.* 2014). Addition of humic acid to the soil, whether by addition or adsorption, both help increase aggregate stability, while the adsorption method gives more significant results (Chaney and Swift 1986). Humin acts as a stable carbon sink, contributing to long-term carbon storage in soils. Fulvic acid and humin also play a significant role in sustainable agriculture and environmental resilience.

**Humic substances and their influence on crop production**

A form of organic material known as humic acid can be used to improve the quality of soil and enable plants to take in more water and minerals. As a consequence of this, there is a possibility that the severity of the condition will decrease as a consequence of this improvement. It's possible that the compounds could directly influence soilborne plant diseases in humic substances. HA is a stable portion of carbon, which regulates and releases nutrients such as nitrogen and phosphorus, which could cause increased growth and yield metrics. This would lower the need for inorganic fertilizer for plant growth. HA stimulates the uptake of major and minor nutrients, the activation and inhibition of enzymes, enhance the activity of microorganism in rhizosphere, improve membrane permeability and protein synthesis, and increase the biomass production. There is a possibility that the potential of humic acid to reduce the severity of diseases that affect strawberry plants is associated with the roots of the plant growing more quickly and, as a result, absorbing a greater quantity of nutrients and water (Khafagi et al. 2018). Humic substances also improves plant photosynthetic activity, plant root growth and supports healthy microbial activity and ultimately enzyme activity.

**Future prospects**

- Application of humic substances with fertilizers opens vast area for study to scientists in future.
- As humin is insoluble in both acid and alkali their application in current aren't evolved, but with modern techniques like NMR (Nuclear magnetic resonance), scanning electron microscope (SEM), X-ray diffraction technique, helps to study their structural composition.
- Currently the cost of production of humic substances is high but with more study and research their production might become economical in future.

**Conclusions**

- Application of humic substances enhances soil physical, biological and chemical properties.
- These substances also increase the cation exchange capacity (CEC) of the soil, enhancing nutrient retention and availability to plants.
- Application of RDF with humic substances, enhance the fertilizer use efficiency.
- Humic substances not completely substitute to chemical fertilizers but acts as complementary to them.
- Application of chemical fertilizers causes environmental pollution (volatilization, Denitrification, Leaching losses) which can be minimized by use of humic substances.
- HA application has potential significant effects on crop agronomic performance and soil quality parameters.
- Application of humic substances show positive effect on soil microbes.
- Humic substances play a crucial role in stimulating soil microbial activity, leading to the breakdown of organic matter and the cycling of nutrients.

**References**

Ampong K, Thilakaranthna M S and Gorim L Y. 2022. Understanding the role of humic acids on crop performance and soil health. https://doi.org/10.3389/fagro.2022.848621.

Billingham, K. L. (2012). "Humic products-potential or presumption for agriculture? Can humic products improve my soil?" in 27th Annual Conference (Orange, NSW: Grassland Society of NSW Inc.).

Billingham, K. L. (2012). "Humic products-potential or presumption for agriculture? Can humic products improve my soil?" in 27th Annual Conference (Orange, NSW: Grassland Society of NSW Inc.).

Biswas, T. D. and Mukherjee, S. K. (1994) testbook of soil science. Tata-McGraw Hill, New Delhi.

Chaney K and Swift R S. 1986. Studies on aggregate stability. The effect of humic substances on the strength of re-formed soil aggregates. Journal of Soil Science 37(2): 337–43.

De Melo, B. A. G., Motta, F. L., and Santana, M. H. A. (2016). Humic acids: Structural properties and multiple functionalities for novel technological developments. Mater.

Sci. Eng. C 62, 967–974. doi: 10.1016/j.msec.2015.12.001

Fahramand M, Moradi H, Noori M, Sobhkhizi A, Adibian M, Abdollahi S and Rigi K. 2014. Influence of humic acid on increased yield of plants and soil properties. International Journal of Farming and Allied Sciences 3(3): 339–41.

Hayes, M. H. B., and Swift, R. S. (2020). Vindication of humic substances as a key component of organic matter in soil and water. Adv. Agron. 163, 1–37. doi: 10.1016/bs.agron.2020.05.001

Khafagi E Y, El-Abeid S E, Soliman M S, El-Nahas S E S M and Ahmed Y. 2018. Role of Arbuscular Mycorrhizae Fungi and humic acid in controlling root and crown rot of strawberry Plant Pathology Journal 17(2): 65–74.

Stevenson, F. J. (1994). "Humus chemistry" Genesis, Composition, Reaction, 2nd Ed. John Wiley & Sons. 13, 236-256 pp.

Tan, X. W., Ikeda, H., and Oda, M. (2000). Effects of nickel concentration in the nutrient solution on the nitrogen assimilation and growth of tomato seedlings in hydroponic culture supplied with urea or nitrate as the sole nitrogen source. Sci. Hortic. 84, 265–273. doi: 10.1016/S0304-4238(99)00107-7.

Wu, S., Li, R., Peng, S., Liu, Q., and Zhu, X. (2017). Effect of humic acid on transformation of soil heavy metals. IOP Conf. Ser. Mater. Sci. Eng. 207, 012089. doi: 10.1088/1757-899X/207/1/012089.

Yang, F., Tang, C., and Antonietti, M. (2021). Natural and artificial humic substances to manage minerals, ions, water, and soil microorganisms. Chem. Soc. Rev. 50, 6221–6239. doi: 10.1039/D0CS01363C.