JUST AGRICULTURE
multidisciplinary e-Newsletter

Harnessing of Humic Substances in Vegetable Crops

V. M. Chaudhari[1*], D. C. Barot[1] and N. K. Patel[2]
[1]Ph.D. Scholar at Department of Vegetable Science, ASPEE College of Horticulture, NAU, Navsari.
[2]Assistant professor at Department of Vegetable Science, ASPEE College of Horticulture, NAU, Navsari.

ARTICLE ID: 26

Abstract

Humic substances play a crucial role in the growth and development of vegetable productions. These substances are organic compounds that are formed from the decomposition of plant and animal matter. They are commonly found in soil, water and sediments. One of the key benefits of humic substances in vegetable productions is their ability to improve soil fertility. They enhance the soil structure by increasing its water-holding capacity, thus preventing waterlogged conditions. Humic substances improve nutrient availability by binding to essential minerals and releasing them slowly to the plants. This ensures a steady supply of nutrients which promoting healthy growth and higher yields. Furthermore, humic substances enhance the root development of vegetable plants. They stimulate root elongation and branching which allowing plants to explore a larger soil volume for water and nutrients. This results in stronger and more efficient root systems, which are essential for the uptake of water and nutrients from the soil. Humic substances also play a significant role in enhancing the plant's tolerance to environmental stress. They act as natural chelators which helping plants to absorb and utilize nutrients more effectively. Moreover, humic substances stimulate the production of plant growth regulators, such as auxins and cytokinins, which are involved in various physiological processes, including stress response.

Keywords: Humic substance, Vegetable crops, Soil improvement, Growth, yield and quality.

Introduction

Humic substances are organic compounds that play a vital role in soil fertility and plant growth. They are formed through the decomposition of plant and animal matter and characterized by their dark color, high carbon content and complex molecular structure. These substances can be found in various forms including humic acids, fulvic acids and humin. In recent years, the use of humic substances in vegetable productions has gained significant

JUST AGRICULTURE
multidisciplinary e-Newsletter

attention due to their numerous benefits for plant health and crop yield (Hartz and Bottoms, 2010).

Types of Humic Substance

1. Humic Acid

Humic acid is one of the primary components of humic substances. It is a dark brown to black in color and amorphous material that is soluble in alkaline solutions. Humic acid is rich in carbon, hydrogen, oxygen, nitrogen and small amounts of sulfur as well as phosphorus. It possesses a high molecular weight and is characterized by its ability to chelate metal ions which improve soil structure and enhance nutrient availability to plants. Humic acid is widely used in agriculture as a soil conditioner and plant growth stimulator (Melo *et al.*, 2016).

Humic Acid

Table 1: Effect of humic acid on vegetable crops

Crops	Effects	Reference
Tomato	HA at 14.4 kg ha^{-1} increased the growth, flowering and yield parameters under heat stress condition.	Abdellatif *et al*., 2017
Potato	HA enhanced the potato plant growth and improved photosynthesis parameters with fresh tuber yield under different water deficits conditions under green house.	Yang *et al.*, 2020
Brinjal	Soil application of HA (30 kg/ha) with $ZnsO_4$ (50 kg/ha) could be	Bhuvaneshwari *et al.*, 2020

JUST AGRICULTURE
multidisciplinary e-Newsletter

	successfully used to obtain better yield in brinjal.	
Chilli	HA applied at 100 mg kg^{-1} resulted in the highest capsaicin and lycopene contents.	Aminifard *et al.*, 2012
Okra	Applications of humic acid (kg ha^{-1}) showed minimum days to first flowering and first picking with maximum leaf area, oven dried single leaf weight and longer production duration.	Haider *et al.*, 2017

2. Fulvic Acid

Fulvic acid is another essential component of humic substances which differing from humic acid in its solubility. It is a yellow to light brown substance that is soluble in both acidic and alkaline solutions. Fulvic acid has a lower molecular weight compared to humic acid which making it more mobile and readily available to plants. It is highly biologically active and acts as a natural chelating agent which facilitating nutrient uptake by plants. Fulvic acid also plays a crucial role in soil aggregation and stabilization, aiding in erosion control (Canellas *et al.*, 2015).

Fulvic Acid

Table 2: Effect of fulvic acid on vegetable crops

Crops	Effects	Reference
Tomato	Fulvic acids increased germination rate, growth vigor and radicle	Zhang *et al.*, 2021

JUST AGRICULTURE
multidisciplinary e-Newsletter

	elongation of tomato seeds, while it increased plant biomass, concentrations of nutrients and root length of tomato plants in hydroponics.	
Potato	fulvic acid (10 kg/fed) with 75% RDF and biochar (5 m^3/fed) recommended for raising potato yield and improving tuber quality	El-Metwaly, 2020
Brinjal	The lower contents of soil fungi (*Aspergillius* spp., *Fusarium* spp. and *Penicillium* spp.) under greenhouse conditions with the treatment of biotechnology fulvic acid with dazomet.	Lan *et al.*, 2020
Chilli	The highest number of fruit $plant^{-1}$, fruit yield m^{-2}, fruit values of vitamin C, total sugars, total soluble solids (TSS) and carotenoids along with the highest cytokines, P, K, Fe and total carbohydrates values were obtained using a soil addition of fulvic acid and spray with seaweed extract at 3 g L^{-1}	Mohamed *et al.*, 2021

3. Humin

Humin is the insoluble fraction of humic substances which constituting the majority of organic matter in soil. It is dark brown to black in color and is not soluble in either acidic or alkaline solutions. Humin is characterized by its high molecular weight and resistance to microbial degradation. It acts as a reservoir of nutrients which providing a slow-release mechanism for plants. Humin also contributes to soil structure formation and water-holding capacity thereby improving soil fertility and moisture retention (Hartz and Bottoms, 2010).

JUST AGRICULTURE
multidisciplinary e-Newsletter

Humin

4. Ulmic Acid

Ulmic acid is a lesser-known component of humic substances which often found in aquatic environments. It is brown to black in color and soluble in alkaline solutions. Ulmic acid is primarily formed through the degradation of lignin, a complex polymer found in plant cell walls. It possesses similar properties to humic acid which including metal chelation and nutrient availability enhancement. Ulmic acid has been studied for its potential applications in water treatment, as it can effectively remove heavy metals and organic pollutants (Hartz and Bottoms, 2010).

Ulmic Acid

5. Lignin

Lignin is a complex polymer that is not strictly considered a humic substance but is closely related. It is a major component of plant cell walls and is responsible for providing rigidity and structural support. Lignin is insoluble in water and is highly resistant to microbial degradation. It contributes to the formation of humic substances through various decomposition processes. Lignin has gained attention for its potential applications in biofuel production and as a natural antioxidant (Hartz and Bottoms, 2010).

Lignin

JUST AGRICULTURE
multidisciplinary e-Newsletter

Role of Humic Substances in Vegetable Productions

1. Soil Fertility

Humic substances are known to improve soil fertility by enhancing nutrient availability and retention. They have a high cation exchange capacity (CEC), which allows them to attract and hold essential nutrients such as potassium, calcium and magnesium. This helps prevent nutrient leaching and ensures that plants have a steady supply of nutrients throughout their growth cycle. Additionally, humic substances promote the development of beneficial soil microorganisms such as mycorrhizal fungi, which further enhance nutrient uptake by plants (Pettit, 2004).

2. Plant Growth and Development

Humic substances have a direct impact on plant growth and development. They stimulate root growth which leading to increased nutrient and water absorption. This results in stronger and healthier plants with improved resistance to environmental stresses such as drought and disease. Humic substances also enhance seed germination and promote the development of a robust root system, which is essential for establishing healthy crops. Furthermore, these substances aid in the synthesis of plant hormones such as auxins and cytokinins, which regulate various growth processes including cell division and elongation (Pettit, 2004).

3. Nutrient Efficiency

One of the key advantages of using humic substances in vegetable productions is their ability to improve nutrient efficiency. They act as chelating agents which forming complexes with micronutrients such as iron, zinc and copper which making them more available for plant uptake. This ensures that plants receive an adequate supply of essential micronutrients, which are crucial for their overall growth and development. Moreover, humic substances can buffer soil pH which preventing nutrient deficiencies or toxicities caused by imbalances in soil acidity (Pettit, 2004).

4. Environmental Sustainability

The use of humic substances in vegetable productions promotes environmental sustainability in several ways. Firstly, by enhancing soil fertility and nutrient availability, these substances reduce the need for synthetic fertilizers and minimizing the risk of nutrient runoff as well as water pollution. Secondly, humic substances improve soil structure and water-

JUST AGRICULTURE
multidisciplinary e-Newsletter

holding capacity which reducing the need for irrigation and conserving water resources. Lastly, by promoting the growth of beneficial soil microorganisms, humic substances contribute to the overall health and biodiversity of the soil ecosystem which enhancing its long-term productivity and sustainability (Pettit, 2004).

Conclusion

Humic substances play a crucial role in vegetable productions by offering numerous benefits for soil fertility, plant growth and agricultural sustainability. Their ability to improve nutrient availability, enhance plant growth and increase nutrient efficiency makes them a valuable tool for farmers and growers. By incorporating humic substances into vegetable production systems, farmers can achieve higher crop yields, reduce the reliance on synthetic fertilizers and promote sustainable agricultural practices. As the demand for organic and sustainable food production continues to rise the use of humic substances in vegetable productions will undoubtedly become more widespread, contributing to the overall improvement of agricultural systems worldwide.

References

Abdellatif, I. M.; Youssef, Y. A.; Yousry, T. A. and Mohamed A. M. (2017). Effect of humic acid on growth and productivity of tomato plants under heat stress. *J. Hortic. Res*., **25**(2): 59-66.

Aminifard, M. H.; Aroiee, H.; Azizi, M.; Nemati, H. and Jaafar, H. Z. (2012). Effect of humic acid on antioxidant activities and fruit quality of hot pepper. *J. Herbs, Spices and Medicinal Pl.*, **18**(4): 1-8.

Bhuvaneshwari, R.; Nayana, N. L.; Srinivasan, S.; Karthikeyan, P. and Suganthi, S. (2020). Response of humic acid and zinc fertilization on the yield characters of brinjal. *Pl. Archives*, **20**(1): 1332-1334.

Canellas, L. P.; Olivares, F. L.; Aguiar, N. O.; Jones, D. L.; Nebbioso, A.; Mazzei, P. and Piccolo, A. (2015). Humic and fulvic acid as biostimulantss in horticulture. *Sci. Hortic.*, **10**: 9-13.

El-Metwaly, H. M. (2020). Response of potato growth yield and quality to fulvic acid and biochar application under different levels of chemical fertilization. *J. Pl. Production*, **11**(2): 10-21.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Haider, N.; Alam, M.; Khan, A.; Haider, W.; Hussain, S.; and Zeb, S. (2017). Influence of humic acid application on phenology, leaf aria and production duration of okra cultivars. *Pure App. Biol.*, **6**(3): 8-10.

Hartz, T. K. and Bottoms, T. B. (2010). Humic substances generally infective in improving vegetable crop nutrient uptake or productivity. *Hort. Sci*., **45**(6): 906-910.

Lan, H.; Yang, W.; Jing, X.; Xiude, X.; Zhang, W.; Zhang, D. and Zhang, M. (2020). Effect of dazomet and biotechnology fulvic acid treatment on fungal diversity in greenhouses soil. *J. Shenyang Agril. Uni.*, **45**(2): 217-220.

Melo, B. A.; Motta, F. L. and Santana, M. H. (2016). Humic acid: structural properties and multiple functionalities for novel technological developments. *Materials Sci. and Eng*., **62**: 967-974.

Mohamed, M. H.; Sami, R.; Mushhin, A. A.; Ali, M. M.; Desouky H. S.; Ismail, K. A.; Khalil, R. and Zewail, R. M. (2021). Impacts of effective microorganisms, compost tea, fulvic acid, yeast extract and foliar spry with seaweed extract on sweet pepper plants under green house conditions. *Pl.*, **10**(9): 1927.

Pettit, R. E. (2004). Organic matter, humus, humate, humic acid, fulvic acid and humic: their importance in soil fertility and plant health. *CTI Res.*, **10**: 1-7.

Yang, M. H.; Zhang, L.; Xu, S.; Neil, B. M. and Liu, J. H. (2020). Effect of water-soluble humic acid applied to potato foliage on plant growth, photosynthesis characteristics and fresh tuber yield under different water deficits. *Sci. Reports*, **10**: 7854.

Zhang, P.; Zhang, H.; Wu, G.; Chen, X.; Gruda, N.; Li, X.; Dong, J. and Duan, Z. (2021). Dise-dependent application of straw derived fulvic acid on yield and quality of tomato plants grown in a greenhouse. *Frontiers in Pl. Sci*., **11**(12): 3399-3408.