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Effect of Humic Acid on Vegetable Crops - A Review

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ABSTRACT

The rapid increase in the world population will also need tremendous amount of food for its survival, this is inevitable. Vegetable crop production has been successfully maximised by conventional production method. But it eventually leads toward deterioration of overall environmental condition of agriculture system. Humic acids derived from soil and applied as soil application, seed or seedling treatment and foliar application, these are important component of soil found to be beneficial for most of the vegetable crops. Various kinds of characteristics like growth, development, yield and quality of vegetable crops has been improved after application of humic acid. Vegetable crops give positive response after application of humic acid in abiotic stress management and production of secondary metabolites. The purpose of this review article is to establish the basic understanding of humic acid and its important in vegetable crops and also emphasizes the results of humic acid on the by-products of the plants.

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INTRODUCTION

A current agricultural system has been well justified by current economical system because the ability to feed an ever-growing population and higher crop productivity, but it also leads the planet closer to scarcity of reserves and eventually starvation and food insecurity (Olivares *et al.* 2017). Intensive usage of chemically synthesized agricultural chemicals in farming is increasing the risk of reducing soil and water quality eventually sustainable agricultural growth (Ekin 2019). Humic acids are one of the important component in soil which have ability to sustain and improve the different physiochemical and biological properties (Meganid *et al.* 2015).

Humic acids are used as an applicable agent as complimentary to chemically synthesized fertilizers or it can reduce the rate of fertilizers when applied along with humic acid and also increase the ability of soil and plants for making better use of minerals and help for soil to becoming self-sufficient by microbiological activities along with humus production (Khaled and Fawy 2011).

Humic acids are basically substance which is brown in color, high molecular weight and soluble in alkali solution. Humic acids are naturally materialized in soli by aging plant material, so it becomes crucial that plant residues and trashes are returned to the soil (Susic 2016). Some locally available material like minimal grade coal is effectively used as good

Table 1. Effect of humic acid on growth, development and yield in vegetable crops.

Crop	Treatment	Result	Reference
Faba bean	Application of different conc. of HA from 0 to 5%	HA @ 5% increased the seed yield (360.50 kg/feddan) compared to control (346.30 kg/feddan)	Dawood *et al.* (2019)
Broccoli	Different conc of HA and bio-fertilizers	Maximum head weight (0.827 kg) and marketable yield (18.31 t/ha) came under bio-fertilizer (20 g/L) + HA (10 ml/L) compared to bio-fertilizer only	Al-Taey *et al*. (2019)
Lettuce	Various conc of HA with both foliar and soil application	Maximum plant height (34.67 cm) from 4.5 ml/L foliar, head weight (718.04 g) and total yield (47.86 t/ha) from 1.5 ml/L soil application was noted	Raheem *et al.* (2018)
Onion	Different dose of HA (0, 500, 750 and 1000 mg/L) with different number of sprays	HA with 1000 mg/L with 3-time spraying showed highest leaves number (10.5), leaf length (57.4 cm) and fresh weight of leaves (95.1 g) compared to other treatments	Al-Fraihat *et al*. (2018)
Tomato	Different type of HA application (soil and foliar) and nutrient mixture (foliar)	Highest total yield was denoted (119.29 t/ha) under the treatment with RDF + HA (10 kg/ha) + HA (0.1% foliar) + Nutrient mixture (foliar) application	Kumar *et al.* (2017)
Potato	Various doses of NPK (full and half dose) with HA (0.03% and 0.5%) along with Zinc and Boron	Half dose of NPK at basal dose + Zn + B + HA @ 0.03% gave highest tuber yield (16589 kg/ha) compared to other treatments	Shah *et al*. (2016)
Okra	HA @ 10, 20, 30 and 40 kg/ha as soil application with 4 okra cultivar Sabz Pari, Arka Anamika, Pusa Sawani and Green Star	Maximum seed germination (74.53%) on Arka Anamika with 10 kg/ha HA dose, pode weight (14.27 g) in Arka Anamika with 20 kg/ha HA dose and also highest in yield (12.85 t/ha)	Haider *et al.* (2017)

source of humic acid (Huculak-Maczka *et al.* 2018) and in several countries, lignite coals are also use as important source of humic acid (Susic 2016). Generally, humic acids are consist of carbon (51%-58%), nitrogen (4%-6%) and phosphorus (0.2%-1%) along with different micronutrients in less amount (Waqas *et al.* 2014). It can be denoted as “plant foods” as they have positive impact on overall plant growth and its enzymatic activities. Most of the crops which are having high carbohydrate index are most responsive with humic acid application (Fagbenro and Agboola 1993). Humic acids are generally considered as soil conditioner or soil amendments (when apply in soil as granule form). It is also applied as drenching and foliar and seed or seedling treatments now a days (Waqas *et al.* 2014).

Using humic acid as bio stimulants in horticulture crops is emerging as a crucial sustainable technology that might be combined with other agricultural techniques in order to increase productivity and efficiency of cropping systems while decreasing their negative environmental effects. There are several formulations based on humic acid that may be used as biologically active natural products in cutting-edge sustainable agriculture.

Vegetable crops are generally considering as heavy feeder of nutrients. So, it became important to study different organic matters which can be apply as substitute for fertilizers. For achieving sustainable vegetable production, improving conditions of soil along with establishing an equilibrium between plant nutrients is crucial which can be achieved by applying bio stimulants like humic acid. Humic acids are not exactly fertilizers because they do not provide any particular nutrients in structured form hence they are important for improving the metabolic activities in plant cells and soil (Tavarini *et al.* 2018).

Humic acid which is applied at higher dose is less effective compared to optimum dose (Lee and Bartlett 1976). Different studies are there which claiming the beneficial effect of humic acid but extensive usage may lead to ecological pollution (Yigit and Dikilitas 2008). There is no outcome of applying of humic acid (Turan *et al.* 2011, Liu and Cooper 2002) as well as growth reduction (Van Tonder 2008) also have been

Table 2. Effect of humic acid on quality of vegetable crops.

Crop	Treatment	Result	Reference
Onion	Pot experiment in which soil is treated with HA @ 1g/pot	Bulb showed higher protein (10.022%) compared to control (9.164%)	Forotaghe *et al*. (2021)
Spinach	Pot experiment with 5 different dose of HA (0.5, 0.75, 1.50, 2.5 and 5 mg/kg soil	Treatment with 5 mg/kg HA in soil gave max. TSS (3.88˚ Brix) and protein (14.55%)	Dubey *et al.* (2019)
Cabbage	Two treatments: Deceneu (0.5%) and Humifert Plus (0.5%) was given	Humifert Plus gave highest ascorbic acid (35.78 mg/100 g fw) compared other treatments.	Rodica *et al.* (2017)
Cucumber	Application of HA @ 100 and 300 mg/L with yeast 2000 and 4000 mg/L	Highest TSS (4.104˚ Brix) was found in HA (300 mg/L) + yeast (4000 mg/L)	Al-madhagi (2019)
Watermelon	3 HA treatments (2,4 and 6 L/feedan) on 2 watermelon variety (Sugar bell, Aswan and Gizal)	Highest TSS and dry matter was found in var Aswan with 6 L/feedan	Salman *et al.* (2005)
Lettuce	Two lettuce varieties: Dark green and Big-Bell and HA was applied as foliar and drenching with NPK	Highest chlorophyll content was found in variety Big-Bell (35.57 SPAD) in treatment with Half NPK + foliar + drenching of HA also similar treatment was responsible for highest nitrate content in lettuce head (1.47 mg/kg)	Shahein *et al.* (2014)
Tomato	Foliar application of HA @ 15 and 30 ppm	HA@ 30 ppm was found for maximum TSS (5˚ Brix), vitamin C (19.76 mg/100 g fw) and fruit lycopene content (2.1 mg/100 g fw)	Kazemi (2014)

found. There was also has been found out that there is positive, nill and negative effects in studies (Lodhi *et al.* 2013).

Effect of humic acid on vegetable growth, development and yield

The effect of application on vegetables with respect of growth, development and yield is given in Table 1. Different studies are there which showed the progressive impact of humic acid on crop growth and development. Various considerations such as root growth, shoot growth, plant height are enhanced with usage of humic acid, which eventually increase the crop yield. Various studies showed that applying of mineral fertilizers and humic acid combined cause slow released of complex nutrients which help in subsequent absorption of nutrients hence good all

Table 3. Effect of humic acid on abiotic stress on vegetable crops.

Crop	Treatment	Result	Reference
Potato	Treatment with 3 bio stimulants (seaweed, fulvic acid and humic acid)	Humic acid gave highest yield 32.83 t/ha under low air temperature and insufficient water at tuber growth period	Wadas and Dziugiel (2019)
Pepper	Application of several dose of phosphorus (0, 50, 100 and 150 mg/kg soil) with HA (0, 750 and 1500 mg/kg soil) under saline soil condition	Treatment with 150 mg phosphorus and 1500 mg HA gave maximum shoot fw (4.82 g), root fw (1.72 g), cotyledon length (18.73 mm) and width (7.80 mm)	Cimrin *et al.* (2010)
Tomato	3 treatment of HA soil application (4.8, 9.6 and 14.4 kg/ha) under hot continental climate	Maximum yield (25 t/ha) was observed in 14.4 kg/ha and maximum TSS (4.1 mg/100 g) observed in 4.8 kg/ha application	Abdellatif *et al.* (2017)
Cucumber	NaCl (0, 28 and 56 mmol/kg soil) + HA (0, 1 and 2 gm/kg soil)	HA @ 1 gm/kg soil gave maximum yield of 480 g/plant and 510 g/plant from 28 mmol NaCl/kg soil and 56 mmol NaCl/kg soil respectively	Demir *et al*. (1997)

Table 4. Effect of humic acid on secondary metabolites of vegetable crops.

Crop	Treatment	Result	Reference
Chilli	RDF and different dose of HA @ 0.5%, 1% and 1.5%	RDF + 6 spray of HA @ 1.5% gave highest capsaicin 1.24%	Pavani *et al*. (2022)
Garlic	Application of different dose of selenium (0, 10, 20 and 30 µg/ml) and HA (0, 10 and 20 kg/ha)	Highest flavonoid content was found 25.587 mg/g of extract with treatment of 30 µg/ml selenium and 20 kg/ha HA	Ghasemi *et al*. (2015)
Chicory	Different levels of HA (0, 0.3, 0.6 and 0.9 kg/ha) was applied	HA @ 0.9 kg/ha gave maximum total flavonoids 484.21 mg/100 gm of dw	Gholami *et al*. (2018)
Carrot	Different amendments: Magnetite 200 kg/fed, humic substances granules and powder form 20 kg/fed	Humic granules @ 20 kg/fed gave highest 7.58 g/100 gm of fw.	Omar and Ramadan (2018)
Fenugreek	Applied HA @ 500 mL/L in irrigation water	High phenol content was found in treatment with HA 98 mg/gm of DW	Mafakheri and Asghari (2018)

overgrowth, development and hence yield (Rose *et al.* 2014, Olaetxea *et al.* 2020).

Effect of humic acid on quality of vegetable crops

Various effects on quality of vegetable crops by applying humic acid is shown in Table 2. It has been discovered that the adding up of humic acid to vegetable crops notably improves their quality. In reaction to the application of humic acid, many parameters including total soluble solids, total acidity, lycopene and nutritional content such Nitrogen, Phosphorus, Potassium, Calcium, and Magnesium are enhanced (El-Nemr *et al.* 2012). The use of humic acid was found to amplify the protein content in cabbage (Verma *et al.* 2014), the starch (Selim *et al.* 2012) and mineral (Suh *et al.* 2014) content in potatoes, and the fruit firmness in cucumber (Sure *et al.* 2012).

Effect of humic acid on abiotic stress on vegetable crops

Different effects on abiotic stress in vegetables by application of humic acid is shown in Table 3. The stress which is induced by abiotic factors like drought stress, salinity stress, high and low temperature stress. Highly impacts the plant growth and development. Under this kind of stress condition, after application of humic acids will lead to enhance the different metabolic pathways to resist and then overcome these critical phases. Specific mechanism which is activated by humic acid in response to these conditions are still under the study (Van Oosten *et al*. 2017).

Effect of humic acid on secondary metabolites of vegetable crops

Effects caused by applying humic acid in secondary metabolites of vegetable crops is demonstrate in Table 4. Secondary metabolites are organic substances created by plants that do not contribute directly to their growth or development but nevertheless have significant ecological and medicinal benefits. Secondary metabolites act as a defensive mechanism against herbivores and pathogens (Wink 2008) as well as possess an important medicinal property (Javanmardi *et al*. 2003) which is one of their primary ecological functions.

CONCLUSION

Humic acids have great potential in terms of vegetable crop production. Various agronomical (growth, development and yield), and biochemical (protein, ascorbic acid, TSS) properties have been improved by its application. To face climate change, humic acids have also been found effective in abiotic stress management and production of secondary metabolites. Hence, the proper structure and mode of action of humic acids on soil as well as plants has been under study. Application of humic acids leads to reduction in use of recommended dose of fertilizers which eventually reduce the cost of cultivation for farmers. More research and development is needed in this field to achieve sustainable crop production.

Study of potency of humic acids based on material by which humic acids has been produced are under researched.

Enrichment of humic acids with biofertilizers and other bio-stimulants to enhance the efficiency.

Improving absorption and reducing the dose of humic acid by enriching it with nano technology.
Humic acids as seed coating, priming or pelleting material.

Large scale manufacturing of humic acids with minimum disturbance of ecosystem.

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