Ecology & Conservation Science: Open Access
ISSN: 2689-4637

Juniper Publishers
key to the Researchers

Mini Review
Volume 3 Issue 1 - August 2023
DOI: 10.19080/ECOA.2023.03.555602

Ecol Conserv Sci

Contribution from Nature to Agricultural Ecosystems: Humic Substances

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Submission: May 01, 2023; **Published:** August 01, 2023

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Abstract

Humic substances are defined naturally occurring of heterogeneous substances resulting from the humification processes of animal and plant matter and microorganisms through the biological activities at certain pressure and temperature and gradually integrated into sediments of brownish coal referred leonardite contain humic acid found in high concentration. Humic acids increase soil cation exchange capacity (CEC), thereby increasing soil fertility by positive ions bind to humic acids that promote conversion of macro and micro essential elements into forms available for plants uptake by their roots. Plants are inevitably exposed to various abiotic stresses during growth and development under natural conditions well as agricultural productions. Humic acids increase resistance to stress plants to various factors of abiotic stress such as drought, salinity, cold, heat as well as biotic ones pests, parasites and pathogens and they buffer the negative effects of excess elements, toxic chemicals and heavy metals from the rhizosphere.

Numerous studies with cultivated plants prove that humic acids, which play a decisive role as a biological stimulant against stress factors in growing conditions, have an important structural and physiological regulatory role in the uptake and transport of nutrients that are effective in the growth and development of roots and shoots of plants. Humic acids improve the physical, chemical and biological properties of the soil. It prevents cracking by increasing the water holding capacity of the soil, enables the seeds to germinate in a shorter time and increases the crumbling and aeration of the soil by loosening the particles by binding to the soil, thus increasing the root formation and especially the vertical growth of the roots. It is predicted that there will be a decrease in the amount of fertilizer applied by preventing the loss of nutrients with the chelating ability of humic acids in growing conditions. The fact that humic acids can be obtained from natural sources such as animal manure, compost, soil and sewage sludge in addition to leonardite proves that there is no harm in using them in traditional and organic farming activities.

Keywords: Agricultural ecosystems; Humic Acids; Plant Germination; Chemical Fertilizers; Humification Processes

Abbreviations: HA: Humic Acids; CEC: Cation Exchange Capacity

Introduction

Agricultural ecosystems are used both as human and animal food sources and to ensure the continuity of natural life. The exponential increase trend in the world population also causes an increase in the demand for food. With the excessive amount of chemical fertilizers used in agricultural areas, which are already limited to meet this increasing demand, the soil loses its naturalness and turns into an unhealthy structure Selim [1]; Akinci [2]; Tiwari [3]. With this in order for humic acids to play an indispensable role in agricultural ecosystems, it is necessary to understand the humification processes, to know the mechanisms of adaptation with the soil and to carry out many applied studies on its effectiveness in sustainable agriculture.

What are Humic Substances?

Humic substances, known commercially as humic acids (HA), are obtained from a variety of sources naturally found in soil, as well as from the mushroom-like pulp of lignite, peat, coal, farm manure, coconut fibers. Peat can be obtained from natural water, rivers, sedimentary layers of the sea, and other chemically and biologically biodegradable materials, but also from peat that is converted to sludge by lignite, oxidized tar coal, leonardite (the oxidation of lignite) Karaca [4]; Akinci [5]. Conservation of soil structure is among the priorities in agriculture. The role of over-fertilization used in agriculture in the food chain has been studied intensively by scientists. Therefore, new searches continue in agricultural ecosystems. First of all, seeking ways to source

environmentally friendly natural fertilizers has become a high priority in agriculture. Numerous studies with humic substances indicate that these humic acids can be used directly on plants as a biostimulant to increase growth, productivity and nutrient uptake Kumar & Aloke [6]. Humic acids create an extremely important environment for the transition of elements from the soil to the plant. Since it has nutrients that the plant needs, it provides the plant by binding insoluble metal ions, oxides and hydroxides in the soil in soluble forms Pettit [7]; Akinci [5]. Humic acids prevent elements such as iron from crystallizing. They can chelate metals and keep them around the root so that the plant can easily use them. It is known that humic acids have a stimulating effect on plant germination and growth Dellamico [8]; Garcia-Mina [9]; Garcia [10]. Humic substances reduce the evaporation rate of water in the soil, increases the cation exchange capacity (CEC) of soils. Another feature of humic substances is that they show buffer properties in a wide pH range. Humic substances are the physical and chemical regulators of the soil. At the same time, humic acids are key components in the position of organic conditioners and have the ability to dissolve in basic pH soil.

Humic Substances and Agricultural Ecosystems

Many studies recent years have shown that the effects of humic acid on culture and natural plants. The responses of cultivated plants to abiotic conditions have been investigated in numerous studies carried out with humic acids in agricultural ecosystems. Some of these are crop plants cultivated in soils with unsuitable conditions for plants such as water stress, salinity, and heavy metals. The root system, like humic acids, has a negative charge, but this negative charge of the root system is greater than that of humic acids. Thus the microelements bound to humic acids are separated and pass through the membrane of the cells in the root to the plant Kulikova [11]; Tipping [12]. Humic substances neutralize the soil pH. When the soil pH is neutralized, many trace elements that are bound and cannot be taken up by plant roots become available. Promoting effects of humic substances is directly related to increasing the intake macronutrients such as N, P and S and micronutrients of Fe, Zn, Cu and Mn. It is known that there is a close relationship between humic acids and hormones. Organic soils rich in matter contain humic substances which can show effects of auxin and other hormones. In all samples containing humic acid, It has been determined that humic acids have a beneficial effect on the growth of coleoptiles. Cacco [13]; Quaggiotti [14]; Kulikova [11]; Chen & Aviad [15]; Fagbenro & Agboda [16] and David [17]. The humic acids used in these studies show a wide variety in the materials from which they are obtained.

The exchange of various organic substances that come to the soil in different ways takes place first, following the mineralization (decomposition) and humification stages Schnitzer [18]; Stevenson [19]. Humic substances are known to protect plants by increasing their water holding capacity and reducing water use to develop resistance under drought stress Jindo [20]. Among the plants where the positive effects of humic substances are seen, there are plants grown under normal conditions and plants that have been treated with humic acid under various stress factors Akinci [5]. These plants studied, for example *Zea mays* Eyheraguibel [21]; Sharif [22], *Vitis vinifera* Ferrara [23] Sunflower Kolsarici [24], watermelon Salman [25], *Lolium temulentum* Bidegain [26], Vicia faba Akinci [27]; Buyukkeskin & Akinci [28]; Buyukkeskin [29], *Cucumis sativus* El-Nemr [30], strawberry Pilanali & Kaplan [31], *Lycopersicon esculentum* David [32]; Dursun [33], *Solanum melongena* Dursun [33], pepper Cimrin [34], wheat Botella [35], corn Turan & Aydın [36], *Phaseolus vulgaris* Aydın [37]; (Meganid 2015; Hemida 2017), *Gossypium barbadense* Rady [38], *Abelmoschus esculentus* L. cv. Sultani Paksoy [39], *Hordeum vulgare* cv. Radegast Jarosova [40], *Linum usitatissimum* L Bakry [41], *Vigna radiata* Kaylon [42], millet seedlings Shen [43], *Petroselinum sativum* Tursun [44].

Conclusions

Agricultural producers, due to high demand for food they use excessive amount of fertilizer to increase the amount of yield as well as the quality. Numerous studies with humic acid have shown that humic acid used in appropriate concentrations is especially beneficial in horticulture and agriculture. Humic acids cannot only be obtained from soil or plants. Humic acids are found in almost every organic matter in nature, in all terrestrial and aquatic ecosystems. There are differences between humic substances obtained from the same source. However, there is a remarkable similarity between the elemental structures of humic substances from different parts of the World Ghabbour & Davies [45]. Humic acid has a positive effect on plant growth and development, especially by providing root development. Humic acid supports root formation as well as H-ATPase enzyme activity of root cells and it increases the nutrient and water intake of plants by stimulating them. The functional groups in the structure of humic acid can bond with metals. Because of this feature, humic acids can prevent the flow of nutrients from soils such as sandy soils with low cation exchange capacity. Excess fertilizer applied to the soil both disrupts the structure of the soil and brings a great cost in terms of economy. Due to the chelating ability of humic acid, its use in agriculture will prevent the loss of nutrients, and there will be a decrease in the amount of fertilizer applied.

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How to cite this article: Sener A. Contribution from Nature to Agricultural Ecosystems: Humic Substances. Ecol Conserv Sci. 2023; 3(1): 555602. DOI: 10.19080/ECOA.2023.03.555602

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DOI: 10.19080/ECOA.2023.03.555602

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