Influence of Foliar and Soil application of Humic Acid on Growth and Yield of Lettuce

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ABSTRACT

The plastic-house experiment was carried out at University of Sulaimani, College of Agricultural Sciences during the growing season of 2016-2017 to determine the effect of soil and foliar application of humic acid on yield and yield components of Lettuce (*Lactuca sativa* L.var Romaine). Four humic acid concentrations (ml.L^{-1}) were sprayed, and soil application of humic acid in four levels that were soil addtions. The design of experiments was a Randomized Complete Block (RCBD) with three replications. The seeds were planted in October 2016; moreover, the lettuce seedlings were transplanted in Novrmber 2016 to the experimental area. The results referred to the highest total yield (47.863t.ha^{-1}) was obtained with treatment T4 followed by treatment T1. Foliar application of 4.5 ml.L^{-1} humic acid (T3) recorded significantly highest plant height as compared with control treatment. In addition the highest values of (TSS) were obtained by soil application (T6) at rate 3.5 ml/L. The data showed that there were no significant differences in the amount of the N, P, K and nitrate in the lettuce product.

Key words: Lettuce, Humic acid, Foliar application, Soil application, Sustainability.

1. INTRODUCTION

According to Food and Agriculture Organization (FAO) of the United Nations the definition of Organic agriculture 'is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs' [1]. Developing ecological knowledge has led to increase people's awareness about food quality, as it has been revealed that traditional intensive agriculture can insert contaminants in the food chain. Purchasers have started to search for better quality of food that produced safely in environmentally friendly condition. Produce food from organic agriculture can be a method for obtaining the above required. Organic agriculture can result in increasing nutrition values and decreasing environmental impacts [2]. One of the applications of organic agriculture is utilizing organic fertilizers that have many forms which include animal sources, plants and mineral sources. Moreover, humic acid is the final breakdown component of the natural decay of animal and plant materials [3, 4 and 5]. Which is one of the types of plant organic fertilizer that has a great role in plant nutrition and soil fertility; in addition, produce higher yields and healthier plant [6]. Humic acid is particularly used to decrease the negative effects of chemical fertilizers and could have beneficial effects on the nutrition of the plant [7]. Furthermore, it has positive influences on the availability of the nutrient, photosynthetic and antioxidant metabolism; enhance leaf water retention [8]. The commercial humic acids were found to improve growth, yield, production, quality and increased significantly in the accumulation of P, K, Ca, Mg, Fe, Zn and Mn in the tissues of some vegetable crops [9] and [10]. Lettuce (Lactucasativa L.) belongs to the family Composite; it is the most popular salad crops in the world. It is popular for its

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delicate, crispy, texture. It is mainly a cold loving crop [11]. Lettuce is low in fat, sodium, and calories. It is an adequate source of iron, fiber, folate, and vitamin C. Moreover, several researches illustrated that HA enhance the number, branch, and length of root [8, 12 and 13]. In addition, in the researches of [14 and 13] demonstrated that HA has positive effects on plant growth directly and indirectly. Direct influence constitute several biochemical actions exerted at wall of the cell, cytoplasm or membrane and primarily of natural hormones. While indirect influences such as, increase of microbial population, increase the nutrients of the soil, and develop the properties of the soil. Chemically, it serves as an adsorption and retention complex for inorganic plant nutrients, physically it improves the structure of the soil and enhances the water holding; furthermore, biologically, it increases the growth of beneficial soil organisms. Lettuce can be grown under protected cultivation or in the open field [15]. The concentration of nitrate in lettuce decreases when the bio fertilizers are used; particularly, nitrobien, biogien [16]. This work was carried out to study the effect of humic acid on the growth, yield and chemical contents of head lettuce plants.

2. METHODS

Lettuce was grown in a plastic house which sites at College of Agricultural Sciences, University of Sulaimani in 2016 2017. The soil characteristics evaluated included physical and chemical as shown in Table (1). The experimental area was tilled, levelled, plotted and mulched by a black polyethylene in August 2016; furthermore, drip irrigation was established. There were 3 blocks which consist of 7 plots that has 6 plants each, the plots divided into 3 rows and 2 columns with length 1.2M and 30 cm space between plants. However, the distance between the blocks was 1M and 0.5M between plots within the units. A total of 126 Lettuce seedlings was transplanted in November 2016 and the design of experiments was a Randomized Complete Block (RCBD) with three replications of 18 Lettuce plants and the means compared according to Dunken at 0.05 level. Humic acid was applied at concentration (0) control, (2.5, 3.5 and 4.5) $ml.L^{-1}$ were sprayed until wet plants completely, while (1.5, 2.5 and 3.5) $ml.L^{-1}$ added to the soil. Data collection was initiated in March 2017 of vegetative growth and reproductive parameters including plant height, unfolded leaf number, dry weight **% [**100 g fresh (folded leaves) in each plot were taken then washed with tap water and oven dried at 70 ^{O}C, then weighted by using sensitive balance**]**, head fresh weight ($gm.plant^{-1}$), total yield ($ton.ha^{-1}$) and chemical characteristics (leaf chlorophyll intensity was measured using digital monitor chlorophyll meter (%) (SPAD 502 PLUS), Total Soluble Solids (TSS %) of (folded leaves), total nitrogen (%), phosphorus (%), potassium (%) and Nitrate contents (%).

Table1. The main physical and chemical properties of the experiment location soil.

Soil properties*	Units	The values
Sand	$g.kg^{-1}$	435.70
Silt		244.50
Clay		319.80
Texture		Sandy clay loam
EC	$d.ms^{-1}$	1.03
PH		7.87
Organic matter	$g.kg^{-1}$	28.90
Available phosphorus		0.03
Soluble potassium		0.08
Total nitrogen	%	1.2

* Data were analyzed in the Central Laboratories of College of Agriculture, University of Baghdad.

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3. RESULTS AND DISCUSSION

Table 2. Effect of foliar and soil application of humic acid on the number of unfolded Lettuce leaves, plant high, chlorophyll, and T.S.S.

Category		No. of unfolded leaves	Plant Height (cm)	Chlorophyll Intensity	T.S.S. (%)
Concentrations (ml/L)	Treatments				
0	T0 (control)	20.67**a**	30.67**b**	48.00**ab**	3.90**a**
2.5	T1 (foliar)	19.00**a**	34.00**a**	48.20**ab**	3.97**a**
3.5	T2 (foliar)	19.67**a**	33.00**ab**	44.80**b**	4.00**a**
4.5	T3 (foliar)	21.33**a**	34.67**a**	47.03**ab**	3.73**a**
1.5	T4 (soil)	21.00**a**	34.00**a**	45.00**ab**	4.00**a**
2.5	T5 (soil)	19.00**a**	33.67**a**	47.03**ab**	3.97**a**
3.5	T6 (soil)	21.33**a**	33.67**a**	48.93**a**	3.57**a**

3.1. Unfolded leaves of lettuce and Plant High (cm**)**

Table (2) shows that there were no significant differences between the treatments in unfolded leaves. While, there were slight significant differences in plant high as effected by HA, compare to control (T0). Besides, T3 has the highest height, which is (34.67 cm). This result is proved by [17] study, whilst it disagrees with the result of unfolded leaves.

3.2. Chlorophyll and T.S.S. (%)

There are no significant differences among the treatments in the amount of relative chlorophyll as it is shown in Table (2). Nevertheless, [18] found that raising levels of humic acid by 100 or 1000 mg/l led to increase photosynthetic activity because of improvement of mesophyll conductance and chlorophyll content. Furthermore, there were significant difference between T4 and T2 with T6 compared to the other treatments in the content of T.S.S which is T4 and T2 has the greatest percentage (4.00%) while T6 has the lowest percentage (3.57%). [19] discovered in the study about the effect of spraying or ground drench of HA on growth and yield of cucumber, that HA treatments considerably increased flowers number and fruit yield; moreover, it has significant positive effects on TSS %, Protein %, and N% content. Nevertheless, Humic acid application has a significant effect on total chlorophyll content [20].

Table 3. Yield characteristics of the lettuce plant treated with HA with different concentrations.

Category		Head fresh weight (gm)	Head dry weight (%)	Total Yield ($ton.ha^{-1}$)
Concentration (ml/L)	Treatments			
0	T0 (control)	558.60**ab**	5.84**a**	37.23**b**
2.5	T1(foliar)	624.44**ab**	5.52**a**	41.62**ab**
3.5	T2 (foliar)	514.37**b**	5.48**a**	34.28**b**
4.5	T3 (foliar)	552.56**ab**	3.98**b**	36.83**b**
1.5	T4 (Soil)	718.04**a**	4.92**ab**	47.86**a**
2.5	T5 (Soil)	549.80**ab**	5.77**a**	36.64**b**
3.5	T6 (Soil)	542.23**ab**	4.99**ab**	36.14**b**

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3.3. Head Fresh weight

The Table (3) illustrates that there are no significant differences among these treatments (T0, T1, T3, T5 and T6), while there are significant differences between treatments T2 and T4. Moreover, treatment (2) has the lowest weight (514.37gm); however, treatment (4) has the highest weight (718.04gm). Perhaps soil and foliar application of humic acid stimulated to higher fruit weight means [20]. [21] Confirmed that using HA and phosphorus together at a rate (300 and 120) $kg.ha^{-1}$ respectively was appropriate for the lettuce head fresh weight.

3.4. Head dry weight

Table (3) shows that there are significant differences in head dry weight. In addition, T3 has the lowest dry weight (3.98%), while the greatest dry weight was given by control (T0). The result was disagreement with [22] investigation; however, in their research combine Nitrogen, Phosphate and Potsium + Humic substances extracted from the compost as foliar + Humic substances extracted from biogas as a soil treatment (NPK+HCF+HBS), while in this research merely used HA. Similar results were investigated by [23], unless they used (humic and fulvic acids). Since, it is explained by [17] that owing to a comparatively short growing season of lettuce the advantages of utilizing humic acid have been limited.

3.5. Total Yield

The influence of HA on total yield of lettuce plants are shown in Table (3). Where the total yield of T4 has the best yield representing (47.86 $ton.h^{-1}$) compared to the other treatments. Whilst, treatment T2 representing the lowest yield, which is (34.28 $ton.h^{-1}$). Although there has been relatively little research on the effect of HA into a total yield of lettuce, [24] discovered that HA with vitamins had not considerable consequence on total yield of lettuce which is agreed with the result of this research. While, the nutrient uptake of vegetable crops affected by HA positively, as a consequence increase growth and yield [25 and 20].

Table 4. Effect of HA on chemical content of head lettuce plant.

Category		N (%)	P (%)	K (%)	No_3 (%)
Concentrations (ml/L)	Treatments				
0	T0 (control)	1.90**a**	0.31**a**	0.43**a**	0.16**a**
2.5	T1(foliar)	1.83**a**	0.30**a**	0.43**a**	0.14**a**
3.5	T2 (foliar)	1.87**a**	0.33**a**	0.44**a**	0.17**a**
4.5	T3 (foliar)	1.88**a**	0.35**a**	0.46**a**	0.15**a**
1.5	T4 (Soil)	2.00**a**	0.33**a**	0.46**a**	0.15**a**
2.5	T5 (Soil)	1.90**a**	0.34**a**	0.45**a**	0.16**a**
3.5	T6 (Soil)	1.79**a**	0.35**a**	0.43**a**	0.17**a**

3.6. The Contents of Nitrogen, Phosphor and Potassium (%):

Table (4) indicates that HA had not effect on the concentration of N, P and K in the lettuce product. However, these results are in contrast with those obtained from [26] and [23].

3.7. Content of Nitrate (No_3)

There are no significant differences amongst the treatments (Table 4). T1 resulted the lowest nitrate (0.14%); additionally, similar results were investigated by [26] and [22] which gave

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the low concentration of nitrate when HA applied to the lettuce plants.

References

[12]Arancon, N.Q., Edwards, C.A., Lee, S. and Byrne, R., 2006. Effects of humic acids from vermicomposts on plant growth. *European journal of soil biology*, *42*, pp.S65-S69.

[4]Baldotto, M.A., Muniz, R.C., Baldotto, L.E.B. and Dobbss, L.B., 2011. Root growth of Arabidopsis thaliana (L.) Heynh. treated with humic acids isolated from typical soils of Rio de Janeiro state, Brazil. *Revista Ceres*, *58*(4), pp.504-511.

[3]Canellas, L.P., Teixeira Junior, L.R.L., Dobbss, L.B., Silva, C.A., Medici, L.O., Zandonadi, D.B. and Façanha, A.R., 2008. Humic acids crossinteractions with root and organic acids. *Annals of Applied Biology*, *153*(2), pp.157-166.

[21]Cimrin, K.M. and I. Yilmaz (2005), "Humic acid applications to lettuce do not improve yield but do improve phosphorus availability*", Acta Agriculturae Scandinavica, Section B-Soil & Plant Science* **55**(1), 58-63.

[1]FAO (2018), "Organic Agriculture" available at http://www.fao.org/organicag/oa-faq/oa-faq1/en/, accessed on 01.March.2018.

[13]Fahramand, M., Moradi, H., Noori, M., Sobhkhizi, A., Adibian, M., Abdollahi, S. and Rigi, K., 2014. Influence of humic acid on increase yield of plants and soil properties. *International Journal of Farming and Allied Sciences*, *3*(3), pp.339-341.[16]Fawzy, Z.F. (2010), "Increasing productivity of head lettuce by foliar spraying of some bio and organic compounds", *Egypt. J. Appl. Sci* **38**(1), 237-247.

[26]Fawzy, Z.F. (2010), "Increasing productivity of head lettuce by foliar spraying of some bio and organic compounds" *Egypt. J. Appl. Sci*, **38**(1), 237-247.

[10]Feibert, E. B., C. C. Shock, and L. D. Saunders (2001), "Evaluation of Humic Acid and Other Non Conventional Fertilizer Additives for Onion Production", *Malheur Experiment Station Annual Report* 2000, **41**.

[24]Filho, B.G.C. (2009), "Growth of lettuce (*Lactuvasativa* L.) in protected cultivation and open field", *J. Appl.Sci. Res.***5**, 529-533.

[16]Hosseny, M.H. and M.M.M. Ahmed (2009), "Effect of nitrogen, organic and bio fertilization on productivity of lettuce (cv. Romaine) in sandy soil under Assiut conditions", *Ass. Univ. Bull. Environ. Res* **12**(1), 79-93.

[20]Karakurt, Y., Unlu, H., Unlu, H. and Padem, H., 2009. The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. *Acta Agriculturae Scandinavica Section B–Soil and Plant Science*, *59*(3), pp.233-237.

[14]Khaled, H. and Fawy, H.A., 2011. Effect of different levels of humic acids on the nutrient content, plant growth, and soil properties under conditions of salinity. *Soil and Water Research*, *6*(1), pp.21-29.

[7]Martinez, M.T., C. Romers and J.M. Gavilen (1983), "Interactions fosboraides hamicos", *A. Fididad X* **1**, 61-62.

[18]Mirdad, Z.M. (2016), "Effect of N Fertigation Rates and Humic Acid on The Productivity of Crisphead Lettuce (Lactuca sativa L.) Grown in Sandy Soil", *Journal of Agricultural Science* **8**(8), 149.

[8]Neri, D., Lodolini, E.M., Savini, G., Sabbatini, P., Bonanomi, G. and Zucconi, F., 2002. Foliar application of humic acids on strawberry (cv Onda). *Acta horticulturae*.

[9]Padem, H., and A. Ocal (1998), "Effects of humic acid applications on yield and some characteristics of processing tomato", In *VI International Symposium on Processing Tomato & Workshop on Irrigation & Fertigation of Processing Tomato* **487**, 159-164.

[6]Pettit, R.E. (2004), "Organic matter, humus, humate, humic acid, fulvic acid and humin: Their importance in soil fertility and plant health", *CTI Research*.

[2]Rembiałkowska, E. (2007), "Quality of Plant Products from Organic

ISSN 2072-3875

Agriculture. Journal of the Science of Food and Agriculture", **87**(15), 2757-2762.

[11]Ryder, E.J. (1999), "Lettuce, endive and chicory–crop production, Science in Horticulture Series", *CABI, Wallingford, UK*.

[15]Salehi, R., A. Kashi and S.M. Mirjalili (2013), "Improvement of lettuce growth and yield with spacing, mulching and organic fertilizer", *International Journal of Agriculture and Crop Sciences* **6**(16), 1137.

[19]Shafeek, M.R., Helmy, Y.I. and Omar, N.M., (2016). Effect of spraying or ground drench from humic acid on growth, total output and fruits nutritional values of cucumber (Cucumis sativus L.) grown under plastic house conditions.

[22]Shahein, M.M., M.M. Afifi and A.M. Algharib (2015), "Study the Effects of Humic Substances on Growth, Chemical Constituents, Yield and Quality of Two Lettuce Cultivars (cv. s. Dark Green and Big Bell)", *Journal of Materials and Environmental Science* **6**(2), 473-486.

[23]Taha, A.A., M.M. Omar and M.A. Ghazy (2016), "Effect of Humic and Fulvic Acids on Growth and Yield of Lettuce Plant", *Journal of Soil Sciences and Agricultural Engineering* **7**(8), 517 – 522.

[17]Tüfenkçi, S., Ö. Türkmen, F. Sönmez, C. Erdinc and S. Sensoy (2006), "Effects of \humic acid doses and application times on the plant growth, nutrient and heavy metal contents of lettuce grown on sewage sludge-applied soils", *Fresenius Environmental Bulletin* **15**(4), 295-300.

[5]Tufail, M., Nawaz, K. and Usman, M., 2014. Impact of humic acid on the morphology and yield of wheat (Triticum aestivum L.). *World Applied Sciences Journal*, *30*(4), pp.475-480.

[25]Zandonadi, D.B., Canellas, L.P. and Façanha, A.R., 2007. Indolacetic and humic acids induce lateral root development through a concerted plasmalemma and tonoplast H+ pumps activation. *Planta*, *225*(6), pp.1583-1595.

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