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ORGANIC PRODUCTION OF URBAN GROWN LETTUCE AND ITS PROTECTION FROM HEAVY METALS

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ABSTRACT

An attempt was carried out in the Vegetable Research Farm, Horticultural Department, Agriculture Faculty, University of Dohuk, during the period from September, 2012 to March, 2013 on the Zakho highway. Iceberg lettuce seeds planed in tow location in the open field (location1) and other inside the plastic house (location 2). Plants present in both locations spraying with different concentrations (0, 0.5, 1, 1.5, 2 and 2.5) $g.L^{-1}$ of potassium humate, some vegetative characters and heavy metals measured. The obtained results revealed that a significant increase in vegetative characters in plants cultured in (location 2) compared with those present in location 1 and significant decrease in amount of heavy metals in plants in location 2 compared with those in location 1 especially Pb and Cu. Also experiment results manifested that spraying plants with potassium humate cased to increase in vegetative growth and decrees effect of heavy metals in plants alone and their combination with locations.

KEYWORDS: Organic Matter Analysis, Asteraceae Family, Humic Acid

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a dicotyledonous plant and a member of Asteraceae family, subfamily Chicorideae. This genus has more than 100 species and 6 types. In the group of leafy vegetables Lettuce is considered as the most important vegetable. Iceberg lettuce *Lactuca sativa* L. *var*. capitata L. is a variety of lettuce with crisp leaves which grows in a spherical head resembling cabbage. Iceberg lettuce is containing of fiber, potassium, calcium, vitamin A, vitamin C and iron. It's has relatively few calories by weight because of its high water content. Humic acid is Organic fertilizers represented by one of the Humus substance compound produced from organic matter analysis [1]. Many studies have mentioned that, humic acid application led to a significant increase in soil organic matter improving plant growth and crop production [2, 3]. Recent investigations on the effects of humic substances on plant growth and mineral nutrition summarize, above all positive effects on seed germination, seedling growth, root initiation, root growth, shoot development and the uptake of some macro (e.g. K, Ca, P) and microelements (e. g. Fe, Zn, Mn) [4, 5]. Many effects of humic substances on the growth of plants are recognized by morphological, physiological and biochemical effects [6, 7]. Furthermore it's used to decrease the negative effects of chemical fertilizers and could have beneficial effect on the nutrition of the plant [8].

Heavy metals are a group of metals that occur naturally it has a relatively high density and is toxic or poisonous at low concentrations. It is well-known Nowadays that cities suffer from considerable pollution as a result to increasing in human population activities, industrialization vehicular emissions, agricultural operations, sewage discharge, and disposal of wastes, as a result various harmful pollutant introduced into the air, water and soil [9]. High vehicle traffic has been considered to be one of the important heavy metals emissions sources. Zinc, copper and lead are three of the most common heavy metals emitted by vehicle traffic, totaling at least 90% from the total emitted quantity [10]. Some previous studies indicate that cadmium concerned one of heavy metal pollutant it is associated with motor traffic and may be released by tyre wear [11]. [12] stated that heavy metals effect on plants through their action, disturb plant metabolism, affecting respiration, photosynthesis, stomata opening and plant growing. In addition to their dangerous effects on human health, including effects upon the central nervous system, developmental delay in children, and cancer.

Protective cultivation is the technique of providing favorable environment condition to the plants. Polyhouse is protective environment the crops can be cultivated successfully throughout the year, getting high productivity with excellent quality, more over it is easy to protect the crops against extreme climatic conditions and incidence of pests and disease, often with earlier maturity, to increase yield, improve quality, enhance the stability of production, and make commodities available when there is no outdoor production. [13] reported that the protected cultivation of vegetable crops suitable for domestic and export purposes could be a more efficient alternative for land use and other resources. The aim of this investigation to determine the effect of humic acid and protected environment and heavy metals content in iceberg lettuce grown in open field and under plastic house conditions.

MATERIALS AND METHODS

The present study was carried out in the Vegetable Research Farm, Horticultural Department, Agriculture Faculty, University of Dohuk, during the period from September, 2012 to March, 2013 on the Zakho highway. Iceberg lettuce seeds planed in the plots fertilized with petmose in 15th September. In 20th November Seedless were cultured in the pots were filled with sand and sheep manure (2:1) with 1seedles per pot diameter 22 cm. pots which placed in tow location in the open field (location1) and other inside the plastic house (location 2) on the Zakho highway.

Organic fertilizers (potassium humate) with different concentrations (0, 0.5, 1, 1.5, 2 and 2.5) g.L^{-1} by foliar spraying were used for plants present in both locations. Spraying was done three times within two weeks intervals, starting from seedless 10 cm. The plants in the plastic house were harvested in 7th March, while in open field were harvested in 28th March, Leaves chlorophyll content %, fresh weight of vegetative growth, dry weight of vegetative growth, number of wrapped leaves and some other vegetative characters measured, then dried in oven at 70°C for 24 hours, dry matter weights measured. The dried samples were ground into fine powder then stored. Dry samples were digested with H_2SO_4 and H_2O_2, the final solution filtered and mineral (lead (Pb), cadmium (Cd) and cupper (Cu)) were measured by using atomic absorption spectrophotometer (AAS) (PYEUNICOM Model SP9). Leaves chlorophyll content % was determined by Chlorophyll Meter, model spad 502 manufactured by `Minolla company, Japan. Randomized Complete Block Design (RCBD) was used for statistical analyses in this experiment. Each treatment was arranged in three replications under open field and plastic house conditions. Data were analyzed by using SAS program [14].

RESULTS AND DISCUSSIONS

- Effect of different locations and concentrations of humic acid and their combination on some vegetative characters of iceberg lettuce

Data presented in the Table (1) indicate that the chlorophyll content increase in leaves plants cultured in plastic house compared with plants cultured in open field. Humic acid at 1.5 g.L^{-1} was obtained best chlorophyll content in leaves plants. While interaction between them was not notice significant increase in chlorophyll content. There is significant increased in vegetative characters in plants cultured under protected cultivation (location 2) compared with those cultured in location 1. The best weights for plants in location 2 fresh weight of vegetative, dry weight of vegetative, head weight, fresh weight of roots and dry weight of roots reached to (198.61 g, 19.06g, 145.56g, 17.56g and 3.29g) respectively as compared with location 1. At all concentrations of humic acid the highest result was obtained when plants spraying with a concentration at 0.5 g.L^{-1}, fresh weight of vegetative (208.33g), dry weight of vegetative (21.41g), head weight (156.67g), fresh weight of roots (21.90g), dry weight of roots (3.24g) as compared with the other humic acid treatments. The same table indicates clearly that the interaction between locations and spraying humic acid, at concentration 0.5 g.L^{-1} in location 2 gave the maximum vegetative weights, while dry weight of roots was observed 2 g.L^{-1} of humic acid as compared with rest combinations.

Table 1: Effect of Different Locations and Concentrations of Humic Acid and Their Interaction on Some Vegetative Characters of Iceberg Lettuce

Characters	Locations	Humic Acid/g.L^{-1}						
		0	0.5	1	1.5	2	2.5	Location Effect
Chlorophyll content %	Location 1	23.43 a	29.07 a	28.93 a	35.63 a	30.13 a	25.77 a	28.83 a
	Location 2	36.03 A	29.27 a	33.57 a	32.03 a	33.13 a	32.30 a	32.72 a
	Humic acid affect	29.73 A	29.17 a	31.25 a	33.83 a	31.63 a	29.03 a	
Fresh weight of vegetative	Location 1	93.33 C	103.33 bc	100.00 bc	93.33 c	76.67 c	80.00 c	91.11 b
	Location 2	276.67 A	313.33 a	140.00 bc	137.67 bc	105.67 bc	218.33 ab	198.61 a
	Humic acid affect	185.00 ab	208.33 a	120.00 bc	115.50 bc	91.17 c	149.17 a-c	
Dry weight of vegetative	Location 1	7.08 d	12.56 cd	9.31 cd	8.53 cd	7.01 d	7.13 d	8.60 b
	Location 2	24.55 ab	30.26 a	13.37 cd	12.64 cd	14.97 b-d	18.58 bc	19.06 a
	Humic acid affect	15.82 ab	21.41 a	11.34 b	10.58 b	10.99 b	12.86 b	
Head weight	Location 1	55.00 bc	71.67 bc	51.67 bc	60.00 bc	40.00 c	40.00 c	53.06 b
	Location 2	190.00 ab	241.67 a	81.67 bc	70.00 bc	56.67 bc	233.33 a	145.56 a
	Humic acid affect	122.50 ab	156.67 a	66.67 ab	65.00 ab	48.33 b	136.67 ab	
Fresh weight of roots	Location 1	7.87 b	12.03 b	10.03 b	8.33 b	5.57 b	5.83 b	8.28 b
	Location 2	13.37 b	31.77 a	13.43 b	20.00 ab	13.43 b	13.33 b	17.56 a
	Humic acid affect	10.62 b	21.90 a	11.73 b	14.17 ab	9.50 b	9.58 b	
Dry weight of roots	Location 1	1.42 ab	2.89 ab	2.59 ab	1.93 ab	1.06 b	1.42 ab	1.89 b
	Location 2	2.89 ab	3.58 ab	3.11 ab	2.65 ab	3.93 a	3.59 ab	3.29 a
	Humic acid affect	2.16 a	3.24 a	2.85 a	2.29 a	2.49 a	2.51 a	

Mean with the same latter for each factor and their interaction are not significantly different at 0.05 level according to Duncan multiple range test

Table (2) reveals the effects of locations and different concentrations of humic acid and their interaction on some characters of iceberg lettuce. It can be noticed that the number of wrapped leaves significantly increased in the open field location as compared in the plastic house, also spraying plants with 0.5 $g.L^{-1}$ humic acid gave the high number of leaves which reached to 19.00 leaves/plant. Humic acid at 0.5 $g.L^{-1}$ in the open field location gave the maximum number of wrapped leaves.

The location 1 had significant effect on the number of non wrapped leaves/plant, the highest leaves number (30.0) was obtained when spraying plants with 0.5 $g.L^{-1}$ humic acid, whereas their combination gave maximam non wrapped Leaves. Significant increase of head diameter was observed under protected cultivation.

Humic acid at 0.5 $g.L^{-1}$ gave highest head diameter. 0.5 $g.L^{-1}$ of humic acid and plastic house characterized by the highest head diameter. The results showed that the Stem length was significantly affected by location and humic acid. The maximum stem length (4.05cm) was obtained when plants were cultured in location 2; it did not show significant differences when different humic acid treatments were sprayed.

The best stem length indicated (5.63cm) was noticed by the interactions between humic acid and location culture. Statistically illustrated there were no significant differences among tow place on plants stem diameter, however an increase stem diameter was noticed at 0.5 $g.L^{-1}$ humic acids. The interaction effects also revealed significant differences, and the treatment of humic acid at (0.5 $g.L^{-1}$ and plastic house gave the highest (11.67cm).

Table 2: Effect of Different Locations and Concentrations of Humic Acid and Their Combination on Some Quality Characters of Iceberg Lettuce

Characters	Locations	Humic Acid/$g.L^{-1}$						
		0	0.5	1	1.5	2	2.5	Location Effect
Number of wrapped Leaves	Location 1	17.67 ab	21.00 a	14.67 ab	17.33 ab	13.67 ab	17.33 ab	16.94 a
	Location 2	11.67 b	17.00 ab	13.33 ab	12.00 b	12.33 b	12.00 b	13.06 b
	Humic acid affect	14.67 ab	19.00 a	14.00 ab	14.67 ab	13.00 b	14.67 ab	
Number of non wrapped Leaves	Location 1	29.33 ab	30.67 ab	31.00 ab	34.33 a	23.00 bc	29.67 ab	29.67 a
	Location 2	28.67 ab	29.33 ab	15.00 c	19.00 bc	19.67 bc	18.67 bc	21.72 b
	Humicacid affect	29.00 a	30.00 a	23.00 a	26.67 a	21.33 a	24.17 a	
Head diameter	Location 1	21.33 b-c	27.33 a-d	18.83 dc	23.67 a-d	15.75 d	19.33 cd	21.04 b
	Location 2	32.33 a-c	36.00 a	23.33 a-d	28.00 a-d	20.00 cd	35.67 ab	29.22 a
	Humic acid affect	26.83 ab	31.67 a	21.08 b	25.83 ab	17.88 b	27.50 ab	
Stem length	Location 1	1.70 bc	1.70 bc	2.00 bc	1.67 bc	1.70 bc	1.33 c	1.68 b
	Location 2	2.50 a-c	5.00 ab	4.67 a-c	2.67 a-c	3.83 a-c	5.63 a	4.05 a
	Humic acid affect	2.10 a	3.35 a	3.33 a	2.17 a	2.77 a	3.48 a	

Table 2: Contd.,

Stem diameter	Location 1	7.03 b	6.67 b	7.33 b	5.57 b	5.83 b	6.33 b	6.46 a
	Location 2	8.33 b	11.67 a	5.83 b	8.00 b	4.83 b	6.00 b	7.44 a
	Humic acid affect	7.68 ab	9.17 a	6.58 b	6.78 b	5.33 b	6.17 b	

Mean with the same latter for each factor and their interaction are not significantly different at 0.05 level according to Duncan multiple range test

- Effect of tow culture locations and different concentrations of humic acid and their combination on some elements in iceberg lettuce leaves

Table (3) shows the effect of protective cultivation and different concentrations of humic acid and their interaction on some elements in leaves iceberg lettuce. Data presented in this table reveal that a significant increased in the content of Cu in leaves of plants planed in location **1** (0.62 $mg.kg^{-1}$) as compared to the content of cu in plants present in the location **2** (0.9 $mg.kg^{-1}$). While different concentrations of humic acid were not notice significant increase on the content of Cu in plants. Concerning the interaction between humic acid and location, a highest Cu content was noticed in location **1** at 0.5 $g.L^{-1}$ humic acid. A significant increase in the amount of Pb was observed in lettuce plants cultured in location **1** as compared to the plants in location **2**, whereas the highest Pb content was noticed when spraying plants with a concentration at 1 $g.L^{-1}$ of humic acid. A maximum amount of Pb (1.48 $mg.kg^{-1}$) was appeared in plants present in location **1** spraying with a concentration at 0.5 and 1 $g.L^{-1}$ of humic acid. There are no significant differences in the content of Cd in the plants which planed in both locations (Table 3). The highest amount of Cd was obtained in plants untreated as compared with different concentrations of humic acid. Locations combination with different concentrations of humic acid effect on the amount of Cd in plants the highest content was appeared location 2 at 1 $g.L^{-1}$ of humic acid.

Table 3: Effect of Tow Culture Locations and Different Concentrations of Humic Acid and Their Combination on Some Elements in Iceberg Lettuce Leaves

Elements/ $mg.kg^{-1}$	Locations	Humic Acid/$g.L^{-1}$						
		C	0.5	1	1.5	2	2.5	Location Effect
Cu	Location 1	0.86 ab	0.89 a	0.41 a-c	0.68 a-c	0.32 a-c	0.59 a-c	0.62 a
	Location 2	0.20 bc	0.05 c	0.07 c	0.06 c	0.09 c	0.06 c	0.09 b
	Humic affect	0.53 a	0.47 a	0.24 a	0.37 a	0.21 a	0.32 a	
Pb	Location 1	1.07 ab	1.48 a	1.48 a	0.65 a-c	0.23 bc	0.23 bc	0.86 a
	Location 2	0.12 c	0.08 c	0.24 bc	0.10 c	0.13 c	0.07 c	0.12 b
	Humic affect	0.59 ab	0.78 a	0.86 a	0.37 ab	0.18 b	0.15 b	
Cd	Location 1	0.23 ab	0.06 bc	0.04 c	0.08 a-c	0.06 bc	0.02 c	0.08 a
	Location 2	0.12 a-c	0.08 a-c	0.24 a	0.10 a-c	0.13 a-c	0.07 a-c	0.12 a
	Humic affect	0.17 a	0.07 ab	0.14 ab	0.09 ab	0.09 ab	0.05 b	

Mean with the same latter for each factor and their interaction are not significantly different at 0.05 level according to Duncan multiple range test

The most results in the table (1 and 2) shows that the planning of ice berg lettuce in plastic house gave best result as compared with open field. Also shows that spraying humic acid with a concentration of 0.5 $g.L^{-1}$ caused significant increased in vegetative growth compared with most others treatment. For the interaction between culture location and different concentrations of humic acid, there is a real effect shown in table (1) and table (2) from the interaction between plastic house 0.5 $g.L^{-1}$ humic acid was significant in its effect. This enhancement in the characteristics of the vegetative growth of plants in plastic house may attribute to the protected cultivation protect the plants from adverse climatic conditions and to provide optimum conditions of light, temperature, humidity etc for the best growth. This is in accordance with [15, 16] who explained that protected cultivation of vegetables could be used to improve yield quantity and quality. This might be due to that the suitable temperature and humidity to plant growth inside plastic house as compared with open field. Air temperature inside the polyhouse was distinctly higher than that at the outside. Also enhances photosynthesis by CO2 released by the plants during nighttime is also trapped inside the greenhouse which is subsequently taken up by the plants itself during daytime in the presence of light [17].

The reasons behind the positive role of relative humidity reduce evaporation loss from plants which lead to optimum utilization of nutrients. It also maintains turgidity of cells which is useful in enzyme activity leading to a higher yield [18]. There are many reports by various researchers reported that the plant height, number of branches of tomato plant, leaf area expansion rate and leaf area index were positively favored due to the warmer environment inside the polyhouse [19, 20, 21] in spite of lower amount of photosynthetically active radiation. This warmer air inside the plastic house caused the soil warming than open field [22]. These results were in accordance with many reports which have shown that Fruit yield was for Okra crop higher inside greenhouse than in the open field due to warm and humid weather inside greenhouse [23]. [24] who working with *Lactuca sativa* during the autumn when showed that the plants in protected cultivation had increase in fresh and dry matter, area foliar and number of leaf. [25, 26] stated that addressed significance of applications of protected cultivation (low plastic tunnel and high plastic tunnel, etc) in the Strawberry. Dry matter production of tomato inside the greenhouse was 2 times greater than that in the open field crop. Species *Lactuca sativa* under protected cultivation showed that despite cycle reduction, the plants presented higher plant matter, when compared with open field [27].

In addition to the effect of plastic house on vegetative growth characters also its effect on the mature of lettuce which caused earliness of 21 days as compared with open field. The current results were agreement with those reported by [28] who stated that high temperature influences crops to mature earlier. The results indicated that protected cultivation caused earliness of 13–20 days when compared to open field. Also [29] have reported that protected cultivation applications could positively affect earliness, yield, and fruit quality traits in the strawberry production. Data presented in the same tables it is clearly shown that humic acid caused increase in vegetative growth characters. Also the interaction between location and humic acid treatments was affect on plants.

The effect of humic acid and interaction with location in increasing growth can be explained that the humic acids were to improve growth, yield production, quality and increased significantly in the accumulation of P, K, Ca, Mg, Fe, Zn and Mn in tissues of some vegetable crops [30]. [31] have mentioned that activity of humic substances was found to be caused by plant hormone-like material contained in the humic substances. Furthermore, other mechanisms which have been suggested to account for promotion of plant growth by humic substances include: enhanced uptake of metallic ions and increases in cell permeability [32]. [33, 34] pointed out that the effects of humic substances on plant growth and mineral nutrition, underlining, above all positive effects on seed germination, seedling growth, root initiation, root growth, shoot development and the uptake of some macro (for example, K, Ca, P) and microelements (for example, Fe, Zn, Mn). The same link was reported by several other authors (The mechanism of humic acid on stimulating growth is similar to plant growth regulators. The ability of humic acid in increasing plant nutrient uptake is due to its chelating property which makes the nutrients more available to plants and due to its ability to enhance cell permeability which in turn makes for a more rapid entry of nutrients into plant cells. Humax can also reduce the surface tension of water and increase the effectiveness of nutrients or chemicals.

These results agreement also with [35] and [36] who investigated the using of humic substances can enhance the growth of roots, shoots and leaves, and encourage nutrient absorption by plants. [37] were observed that treatment with 20 and 50 mgl^{-1} humic acid in lettuce increased characteristics significantly. Similar result had been stated by [38] who concluded that humic acid increased head weight of lettuce (*Lactuca sativa* L. *var. longifolia*) by increasing the availability of phosphorus and nitrogen. [39] mentioned that the use of humic acid and chemical fertilizers improves nutrient absorption in lettuce (*Lactuca sativa*). Humic substances also observed on yield increases on radish and green bean seedings [40]. The beneficial effects of the humic substances on corn and oat seedling were observed on the studies such as dry matter yield increases [41]. As appear in the results the number of wrapped Leaves and number of non wrapped Leaves planning of ice berg lettuce in open field gave highest number result as compared with plastic house. The may be du to the high size and weight of plant in the plastic house caused decrease in the number of leaves.

It was clear from the results in table (3) that the different culture locations and different concentrations of humic acid and their interactions has affect on the amount of elements in the plants leaves. Uptake and accumulation of elements by plants may follow paths through the roots and foliar surface [42]. [43] observed that the plants are able to take up elements via the leaf surface both via stomata (gases) and via the cuticle (ions). [44] illustrated that inorganic elements penetration in leaves depend on abiotic conditions (humidity, temperature, inorganic element nature and speciation). Also investigated by [45] how size of solutes and temperature affect diffusion in plant cuticle. The higher temperatures induced a relative humidity under the protective cultivation due to reduced transpiration in the protected zone, which produced a mini-greenhouse effect [46].

Similar result had been stated by [47] who reported that an increase in relative humidity decreased transpiration in plants. This decrease in the amount of the elements in plastic house plants as compared with plants in open field may attribute to the increase of in relative humidity in plastic house that lead to decreased transpiration by closing of stomata. Thermal conditions protective cultivation increased the concentration of heavy metals, mainly Zn and Cd [48]. In additionally that humic acids promote plant growth and increase of yield, but its leads to reduce of some heave metals damages as showed in data present in Table (3).

Many studies and reviews on the ability of humic acid to affect plant micronutrient uptake due to their ability to complex metals under different environmental conditions have been published [49]. Humic acid would be expected to reduce cadmium's bioavailability, and indeed most experiments run in the presence of humic acid show such a decrease [50]. [51] stated that the humic acid applied in the media led to a decrease the metal adsorption by plant and can be used to reduce the availability and mobility of heavy metals in the soils, too.

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