

Effect of Humic and Fulvic Acids on Growth and Yield of Lettuce Plant.

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ABSTRACT

A pot experiment was carried out during the winter season of 2014 under alluvial soil at the green house of Soils Dept. Faculty of Agriculture, Mansoura University. The aim of this experiment is to study the response of lettuce plant to different rates of humic substances (humic and fulvic acids). The experiment treatments included four different application rates of humic and fulvic acid (0, 7, 10 and 13 kg fed⁻¹) using three methods of application (soil, fertigation and foliar applications). The used experimental design was a split plot design with three replicates for each treatment. The effects of soil applications, fertigation and foliar of humic substances on the plant growth and some nutrient elements uptake of lettuce (*Lactuca sativa L.*) grown under different rates were examined. The results of the present study showed that the significant effects of different application rates of humic substances on fresh and dry weights, plant height, N%, P % and K%. The results indicated that the highest values of fresh and dry weight of shoot as well as plant height (cm) were at foliar addition of fulvic acid at 13 kg fed⁻¹ treatment. Also, the nutrient content (N, P, and K) of lettuce was significantly increased with raising of application rates of humic substances.

Keywords: Lettuce plants; Humic acid ; Fulvic acid , Nutrient content, Plant growth.

INTRODUCTION

The application of Humic substances for soil O.M management is optimum management practice to face the current Environmental challenges of increasing green House CO₂ emissions. Several investigations suggested the beneficial effect of using humic substances in horticultural systems including reducing mineral fertilizers application, increasing of fertilizers use efficiency, increasing of plant tolerance against environmental stresses, reducing the hazardous effect of plant pathogens, stimulating early growth and maximizing the produced yield (Seliim and Moosa 2012; Naidu *et al.*, 2013 and Deenre *et al.*, 2014). H.S may be absorbed by the roots, transported to shoots, enhancing the growth of the whole plant. Also, it can be added to the soil for improvement of the crops yield. There are divergent findings about humic substances effects on plants. Application of H. substances can potentially stimulate crop growth and development through the actions of plant growth promoting hormones, including cytokinins, Auxins, and Gibberellins. Its effects may be attributed to many factors, including the natural source and concentration of humic substances, soil pH, and plant species. A benefit of humic acid due to its ability to complex metal ions and form aqueous complexes with micronutrients and also may form an enzymatically active complex, which can be carried on reactions that are usually assigned to the metabolic activity of living microorganisms. So, the use of these organic substances in such soil showed a good means in that concern. The major functional groups of humic acid include carboxyl, phenolic hydroxyl, alcoholic hydroxyl, ketone and quinoid. There is a paucity of information on the use of humic substances as fertilizers for vegetable production.

Lettuce (*Lactuca sativa L.*) is the most popular among the salad crop. It is among the top five most commonly consumed vegetables in the U.S. State. Lettuce is considered as an excellent nutritive source of Minerals and Vitamins as it is consumed as a fresh green salad. In Egypt, The cultivated area of lettuce is about 3120 hectares, which produced about 68644 tons (Sshahein *et al.*, 2014).

This research aimed to study the response of lettuce plant to different levels of humic substances (humic and fulvic acids) under an alluvial soil conditions as well as to study their effects on some soil properties, plant growth, yield and chemical composition of lettuce plant.

MATERIALS AND METHODS

Response of lettuce to different levels of humic substances (humic and fulvic acids) under alluvial soil conditions. Surface soil samples (0-30 cm) were collected from a private farm in Mahalla district, Gharbia Governorate to represent an alluvial soil; the collected samples were air-dried, crushed, and passed through a 2 mm sieve and preserved for analysis. Some physical and chemical properties of the studied soil are shown in Table (1).

Table (1):- Some physical and chemical characteristics of soil.

Soil characteristics	Values	
Sand (%)	24,95	
Silt (%)	25,05	
Clay (%)	50,00	
Soil texture	Clay	
Field capacity (%)	35.0	
Saturation (%)	70,0	
Calcium carbonate (%)	4.00	
OM (%)	1.4	
pH*	7.80	
EC** (dSm-1)	0.73	
	Ca ⁺⁺	2.10
	Mg ⁺⁺	1.1
	Na ⁺	3.10
	K ⁺	1.000
		N.D.***
soluble ions**	CO ₃ ⁻	
	Soluble anions (meq L-1)	
	HCO ₃ ⁻	0.40
	Cl ⁻	3.00
	SO ₄ ⁻	3.90
Available (mg/kg)	N	40.4
	P	5.9
	K	285.3

The used experimental design was a split plot design with three replicates for each treatment. The humic treatments were: (H₀) without Humic acid application, (H₁) Soil humic acid application at three rates 7, 10 and 13 kg Fed⁻¹, (H₂) application of humic acid with irrigation water at three rates 7, 10 and 13 kg

fed⁻¹ and (H₃) foliar application of humic acid at three rates 7, 10 and 13 kg fed⁻¹. The fulvic treatments were: (F₀) without fulvic acid application, (F₁) soil fulvic acid application at three rates 7, 10 and 13Kg Fed⁻¹, (F₂) application of fulvic acid with irrigation water at three rates 7, 10 and 13 kg fed⁻¹ and (F₃)foliar application of fulvic acid at three rates 7, 10 and 13 kg fed⁻¹. 4 lettuce seedlings were sown in closed plastic pots (10 kg) in December 9, 2014. Irrigation was applied to reach the field capacity and the assumed field capacity was readjusted very week. Mineral fertilizers were applied at rates of 100 kg fed⁻¹ ammonium sulfate, 250 kg fed⁻¹ super phosphate and 50 kg fed⁻¹ potassium sulfate.

RESULTS AND DISCUSSION

1-Fresh, dry weight and plant height of lettuce shoots as affected by different levels of humic and fulvic acid used different addition methods.

Data illustrated in Table (2) show the effect of

Table (2). Fresh, dry weight (g/pot) and Plant height (cm) of lettuce shoot after 50 day from planting as affected by different levels of humic and fulvic acid using different addition methods .

Treat.	Char.	Humic acid			Fulvic acid		
		Fresh weight	Dry weight	Plant height	Fresh weight	Dry weight	Plant height
Soil application	(T1) 7 Kg Fed ⁻¹	91.0	4.45	26.3	93.6	4.68	26.8
	(T2) 10 Kg Fed ⁻¹	123.7	6.18	27.2	132.2	6.60	27.5
	(T3) 13 Kg Fed ⁻¹	129.4	6.46	27.5	139.1	6.95	27.8
With irrigation water	(T4) 7 Kg Fed ⁻¹	98.06	4.90	27.3	100.7	5.03	28.2
	(T5) 10 Kg Fed ⁻¹	133.6	6.68	27.9	142.4	7.12	28.6
	(T6) 13 Kg Fed ⁻¹	140.3	7.01	28.5	150.7	7.48	29.2
	(T7) 7 Kg Fed ⁻¹	110.8	5.53	28.2	122.7	6.13	31.8
Foliar application	(T8) 10 Kg Fed ⁻¹	137.7	6.86	28.9	155.9	7.79	32.0
	(T9) 13 Kg Fed ⁻¹	156.1	7.80	29.6	166.4	8.31	33.25
Control (without HA or FA)		73.4	3.66	25.6	73.4	3.66	25.6
LSD at 5%		2.2	0.18	0.10	1.5	0.25	0.20

Data in Table (2) and Figures (1, 2and3) indicate also that, using different doses of fulvic acid led to a significant increase in all plant growth parameters of lettuce where the shoot fresh weight of lettuce grown on alluvial soil was increased from 73.4 at control (without HA or FA) to 93.6, 132.2, 139.1, 100.7, 142.4, 150.7, 122.7, 155.9 and 166.4g at T₁, T₂, T₃, T₄, T₅, T₆, T₇, T₈ and T₉, respectively. Also, the shoot dry weight and

different doses of humic substances(Humic and Fulvic acid)on the average values of fresh ,dry weight (g/pot) and height(cm) of lettuce shoots grown on alluvial soil with three different methods of application after 50 days from planting .

Data in Table (2) show that fresh & dry weight (g) and height of lettuce shoot significantly increased with the increase of humic substances application dose but the resulting increase for fulvic acid is greater than humic acid.

From data in Table (2) and Figures (1, 2and3) it was found that, With humic acid, The shoot fresh weight of lettuce grown on alluvial soil was increased from 73.4 at control (without HA or FA) to 91.0, 123.7, 129.4, 98.06, 133.6, 140.3, 110.8, 137.7and 156.1g at T₁, T₂, T₃, T₄, T₅, T₆, T₇, T₈ and T₉, respectively. Also, the shoot dry weight and height of lettuce grown were increased from 3.66 and 25.6 at control (without HA or FA) to 7.80 and 29.6 at T₉treatment where the increasing rate is (113%) and (15.6%), respectively

height of lettuce grown were increased from 3.66 and 25.6 at control (without HA or FA) to 8.31and 33.25 at T₉treatment where the increasing rate is (127%) and (29.8%), respectively.

Similar results were investigated by (Chen and Aviad 1990; Piccolo *et al.*, 1993; Selim and Mosa 2012; Naidu *et al.*, 2013).

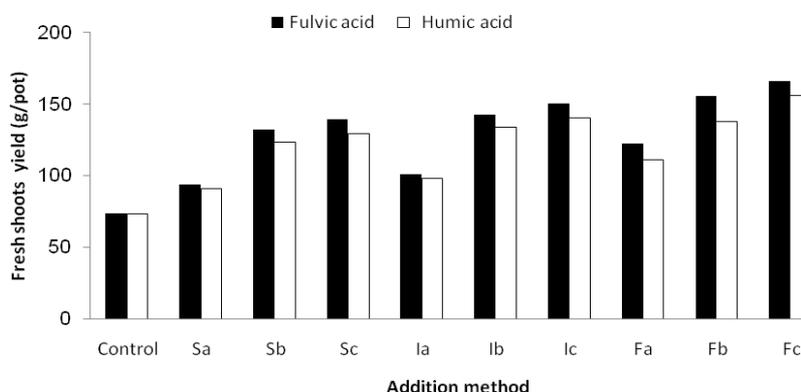


Fig (1): Effect of different levels of humic and fulvic acid under different addition methods on fresh yield of lettuce shoots after 50 day from planting.

Sa: Soil application(7 Kg Fed⁻¹); Sb: Soil application(10 Kg Fed⁻¹); Sc: Soil application(13 Kg Fed⁻¹); Ia: With irrigation water(7 Kg Fed⁻¹); Ib: With irrigation water(10 Kg Fed⁻¹); Ic: With irrigation water(13 Kg Fed⁻¹); Fa: Foliar application(7 Kg Fed⁻¹); Fb: Foliar application(10 Kg Fed⁻¹); Fc: Foliar application(13 Kg Fed⁻¹) and Control (without HA or FA).

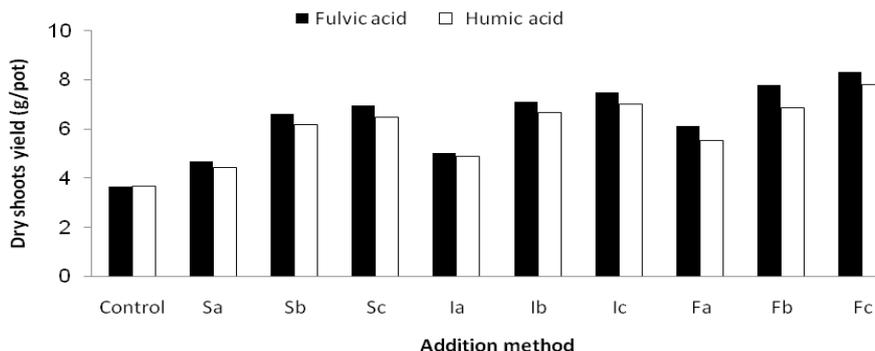


Fig (2): Effect of different levels of humic and falvic acid under different addition methods on dry yield of lettuce shoots after 50 day from planting.

Sa: Soil application (7 Kg Fed⁻¹); Sb: Soil application (10 Kg Fed⁻¹); Sc: Soil application (13 Kg Fed⁻¹); Ia: With irrigation water (7 Kg Fed⁻¹); Ib: With irrigation water (10 Kg Fed⁻¹); Ic: With irrigation water (13 Kg Fed⁻¹); Fa: Foliar application (7 Kg Fed⁻¹); Fb: Foliar application (10 Kg Fed⁻¹); Fc: Foliar application (13 Kg Fed⁻¹) and Control (without HA or FA).

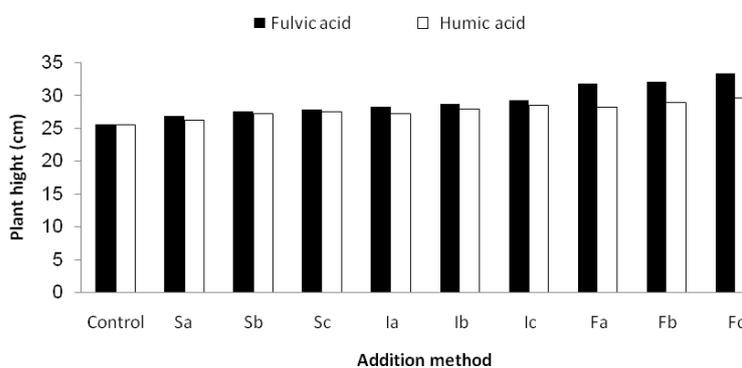


Fig (3): Effect of different levels of humic and falvic acid under different addition methods on plant height after 50 day from planting.

Sa: Soil application (7 Kg Fed⁻¹); Sb: Soil application (10 Kg Fed⁻¹); Sc: Soil application (13 Kg Fed⁻¹); Ia: With irrigation water (7 Kg Fed⁻¹); Ib: With irrigation water (10 Kg Fed⁻¹); Ic: With irrigation water (13 Kg Fed⁻¹); Fa: Foliar application (7 Kg Fed⁻¹); Fb: Foliar application (10 Kg Fed⁻¹); Fc: Foliar application (13 Kg Fed⁻¹) and Control (without HA or FA).

data of table (3) and Figeres (4,5 and 6) showed the effect of different doses of humic substances (Humic and Fulvic acid) on plant growth parameters of lettuce in expression of plant height (cm) and fresh & dry weight (g/pot) for lettuce grown on alluvial soil with three different methods of application at harvesting (after 100 day from planting).

As shown in Table (3) and Figeres (4, 5 and 6), the highest mean values of all plant growth parameters

under study were realized due to the addition of humic substances as foliar application followed by fertigation and soil application, respectively. This is a general trend in both types of humic substances (HA and FA), but the results under FA are higher than the results under HA. While the lower values for plant height and fresh & dry weight were obtained at control treatment (without HA or FA).

Table (3). Fresh, dry weight (g/pot) and Plant height (cm) of lettuce shoot after 100 day from planting (at harvesting) as affected by different levels of humic and falvic acid using different addition methods .

Treat.	Char.	Humic acid			Fulvic acid			
		Fresh weight	Dry weight	Plant height	Fresh weight	Dry weight	Plant height	
Addition method	Soil application	(T1) 7 Kg Fed ⁻¹	300.73	15.03	26.0	305.83	15.28	28.0
		(T2) 10 Kg Fed ⁻¹	314.3	15.71	27.0	319.33	15.96	29.0
		(T3) 13 Kg Fed ⁻¹	324.26	16.22	27.5	333.0	16.64	29.5
	With irrigation water	(T4) 7 Kg Fed ⁻¹	309.06	15.45	29.0	311.8	15.58	31.0
		(T5) 10 Kg Fed ⁻¹	319.56	15.97	30.0	328.5	16.42	32.0
		(T6) 13 Kg Fed ⁻¹	334.3	16.71	31.0	342.03	17.10	33.0
	Foliar application	(T7) 7 Kg Fed ⁻¹	315.13	15.75	34.0	325.96	16.29	37.0
		(T8) 10 Kg Fed ⁻¹	331.0	16.54	35.0	352.8	17.63	38.0
		(T9) 13 Kg Fed ⁻¹	343.33	17.18	36.0	375.83	18.79	39.0
Control (without HA or FA)		276.16	13.8	24.0	276.16	13.8	24.0	
LSD _{at 5%}		1.05	0.6	1.1	1.4	0.66	0.2	

With humic acid, the difference between the mean values of such traits was significant. For example; the highest mean values for plant height (cm) and fresh & dry weight (g/pot) were 36, 343.33 and 17.18, respectively, were realized for the plant treated with HA as foliar addition at a rate of 13 Kg Fed⁻¹. Also, the increasing rate of plant height and fresh & dry weight of lettuce plant from control treatment (without HA or FA) to T₉ treatment is (50%), (24.3%) and (24.49%), respectively.

Results in Table (3) and Figs.4, 5 and 6 show that adding different doses of fulvic acid at a rate of 13 Kg Fed⁻¹ gave the highest values of plant height and fresh

& dry weight for lettuce plant. For example; the shoot fresh weight of lettuce grown on alluvial soil was increased from 276.16 at control (without HA or FA) to 305.83, 319.33, 333.0, 311.8, 328.5, 342.03, 325.96, 352.8 and 375.83 g at T₁, T₂, T₃, T₄, T₅, T₆, T₇, T₈ and T₉, respectively. Also, the shoot dry weight and height of lettuce grown were increased from 13.8 and 24 at control (without HA or FA) to 18.79 and 39.0 at T₉ treatment where the increasing rate is (36.15%) and (62.5%), respectively.

The present results agree with those obtained by (Selim and Mosa 2012; Naidu et al., 2013).

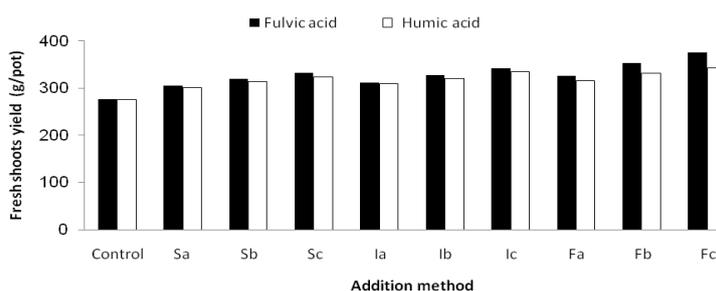


Fig (4) Effect of different levels of humic and falvic acid under different addition methods on fresh yield of lettuce shoots at harvesting.

Sa: Soil application (7 Kg Fed⁻¹); Sb: Soil application (10 Kg Fed⁻¹); Sc: Soil application (13 Kg Fed⁻¹); Ia: With irrigation water (7 Kg Fed⁻¹); Ib: With irrigation water (10 Kg Fed⁻¹); Ic: With irrigation water (13 Kg Fed⁻¹); Fa: Foliar application (7 Kg Fed⁻¹); Fb: Foliar application (10 Kg Fed⁻¹); Fc: Foliar application (13 Kg Fed⁻¹) and Control (without HA or FA).

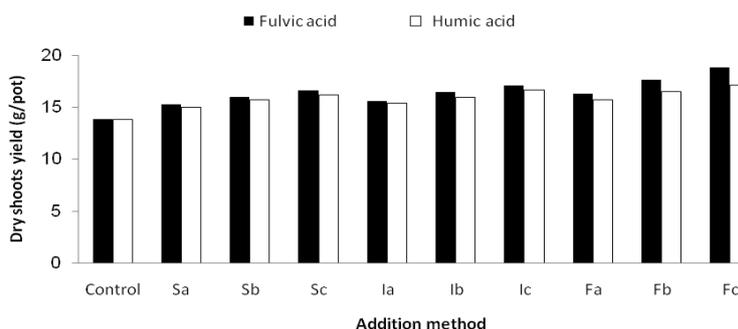


Fig (5) Effect of different levels of humic and falvic acid under different addition methods on dry yield of lettuce shoots at harvesting.

Sa: Soil application (7 Kg Fed⁻¹); Sb: Soil application (10 Kg Fed⁻¹); Sc: Soil application (13 Kg Fed⁻¹); Ia: With irrigation water (7 Kg Fed⁻¹); Ib: With irrigation water (10 Kg Fed⁻¹); Ic: With irrigation water (13 Kg Fed⁻¹); Fa: Foliar application (7 Kg Fed⁻¹); Fb: Foliar application (10 Kg Fed⁻¹); Fc: Foliar application (13 Kg Fed⁻¹) and Control (without HA or FA).

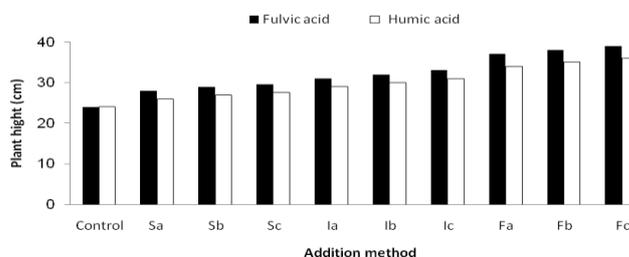


Fig (6) Effect of different levels of humic and falvic acid under different addition methods on lettuce height at harvesting.

Sa: Soil application (7 Kg Fed⁻¹); Sb: Soil application (10 Kg Fed⁻¹); Sc: Soil application (13 Kg Fed⁻¹); Ia: With irrigation water (7 Kg Fed⁻¹); Ib: With irrigation water (10 Kg Fed⁻¹); Ic: With irrigation water (13 Kg Fed⁻¹); Fa: Foliar application (7 Kg Fed⁻¹); Fb: Foliar application (10 Kg Fed⁻¹); Fc: Foliar application (13 Kg Fed⁻¹) and Control (without HA or FA).

2- N, P and K percentage in shoots of lettuce plant as affected by different levels of humic and fulvic acid using different addition methods.

N.P and K (%) in shoot of lettuce plants as influenced by different doses of humic substances(Humic and Fulvic acid)under different addition methods after 50 day from planting are presented in Table (4).

In regard to the effect of humic substances, data presented in Table 4 show a superior effect for HA and FA on the mean values of N, P and K (%) in lettuce plants. The highest value of N, P and K (%) was given with increasing of application dose to 13 KgFed⁻¹ under foliar application. So it can be said that foliar adding of HA and FA induced positive effect on N, P and K% in lettuce shoot greater than soil application and fertigation

Table (4). N, P and K percentage (%) in shoots of lettuce plant after 50 day from planting as affected by different levels of humic and fulvic acid using different addition methods.

Treat.	Char.	Humic acid			Fulvic acid		
		N(%)	P(%)	K(%)	N(%)	P(%)	K(%)
Addition method Soil application	(T1) 7 Kg Fed ⁻¹	1.4	0.25	1.7	1.5	0.25	1.8
	(T2) 10 Kg Fed ⁻¹	1.55	0.25	1.8	1.75	0.25	2.0
	(T3) 13 Kg Fed ⁻¹	1.7	0.30	1.9	1.95	0.30	2.1
	(T4) 7 Kg Fed ⁻¹	1.6	0.29	1.85	1.7	0.30	1.95
With irrigation water	(T5) 10 Kg Fed ⁻¹	1.7	0.30	1.9	1.85	0.30	2.05
	(T6) 13 Kg Fed ⁻¹	1.8	0.30	2.1	2.0	0.30	2.25
	(T7) 7 Kg Fed ⁻¹	1.8	0.30	1.95	1.9	0.30	2.1
Foliar application	(T8) 10 Kg Fed ⁻¹	2.0	0.30	2.1	2.15	0.35	2.2
	(T9) 13 Kg Fed ⁻¹	2.1	0.35	2.25	2.3	0.35	2.3
Control (without HA or FA)		1.2	0.20	1.5	1.2	0.20	1.5
LSD _{at 5%}		0.30	0.02	0.6	0.25	0.04	0.5

With humic acid, The values of N,P and K(%)lettuce grown on alluvial soil were 1.2,0.20 and 1.5 for control (without HA or FA),while the highest values were 2.1,0.35 and 2.25% atT₉ treatment , respectively . Similar trend was found for the concentration of N, P and K in lettuce grown with fulvic acid. The present results agree with those obtained by (Selim and Mosa 2012) .

.This trend was for both humic substances (HA and FA) under study.

Nitrogen, Phosphorus and potassium concentration (%) in shoot of lettuce plants as influenced by different doses of humic substances(Humic and Fulvic acid)under different addition methods after 100 day from planting (at harvesting) are tabulated in Table (5).

Data presented in Table 5show a superior effect for HA and FA on the mean values of N, P and K (%) in lettuce plants at harvesting. The highest value of N, P and K (%) was given with increasing of application dose to 13 KgFed⁻¹ under foliar application. So it can be said that foliar adding of HA and FA induced positive effect on N, P and K% in lettuce shoot greater than soil application and fertigation .

Data demonstrate that the best addition method was foliar application as well as the increase in application dose of humic substances had a significant effect on N, P and K (%) in shoots of lettuce grown

With humic acid, The values of N,P and K(%)lettuce grown on alluvial soil were 1.3,0.20 and 1.6 for control (without HA or FA),while the highest values were 2.4,0.35 and 2.55% atT₉ treatment , respectively . Similar trend was found for the concentration of N, P and K in lettuce grown with fulvic acid. The present results agree with those obtained by (Denre *et al.*, 2014).

Table (5). N, P and K percentage (%) in shoots of lettuce plant after 100 day from planting as affected by different levels of humic and fulvic acid using different addition methods .

Treat.	Char.	Humic acid			Fulvic acid		
		N(%)	P(%)	K(%)	N(%)	P(%)	K(%)
Addition method Soil application	(T1) 7 Kg Fed ⁻¹	1.7	0.25	2.0	1.8	0.25	2.1
	(T2) 10 Kg Fed ⁻¹	1.85	0.3	2.1	2.05	0.25	2.3
	(T3) 13 Kg Fed ⁻¹	2.0	0.30	2.2	2.30	0.3	2.3
	(T4) 7 Kg Fed ⁻¹	1.9	0.29	2.00	2.00	0.3	2.2
With irrigation water	(T5) 10 Kg Fed ⁻¹	2.05	0.3	2.2	2.15	0.3	2.35
	(T6) 13 Kg Fed ⁻¹	2.15	0.3	2.4	2.30	0.35	2.55
	(T7) 7 Kg Fed ⁻¹	2.1	0.30	2.3	2.20	0.35	2.4
Foliar application	(T8) 10 Kg Fed ⁻¹	2.3	0.30	2.4	2.45	0.35	2.5
	(T9) 13 Kg Fed ⁻¹	2.4	0.35	2.55	2.60	0.35	2.6
Control (without HA or FA)		1.3	0.20	1.6	1.30	0.20	1.6
LSD _{at 5%}		0.25	n.s	1.02	0.1	n.s	0.05

CONCLUSION

the addition of humic substances (humic and fulvic acid) significantly increase the plant growth and mineral contents of lettuce plant especially when increasing of application dose but the positive effect of fulvic acid is greater than the positive effect of humic acid.

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تأثير حمض الهيوميك والفاليك علي نمو ومحصول نبات الخس أحمد عبد القادر طه , محمود موسى عمر ومحمد عباس غازي قسم الأراضي, كلية الزراعة، جامعة المنصورة

أجريت تجربة أصص خلال الموسم الشتوي 2014 بمزرعة كلية الزراعة –جامعة المنصورة لدراسة مدي إستجابة نبات الخس للجرعات المختلفة من المواد الدبالية (حمض الهيوميك والفاليك) تحت طرق إضافة مختلفة. معاملات التجربة اشتملت علي أربع جرعات مختلفة من الهيوميك (صفر و7 و10 و13 كجم هيوميك/الفدان) وكذلك أربع جرعات أخري للفاليك (صفر و7 و10 و13 كجم فاليك /الفدان) وذلك تحت ثلاث طرق إضافة مختلفة (الإضافة الأرضية و الإضافة مع ماء الري و الإضافة رشا). ولقد أجريت التجربة باستخدام تصميم القطع المنشقة في ثلاث مكررات. ولقد أشارت النتائج إلي أن أفضل القيم لكل من الوزن الطازج والجاف للمجموع الخضري و طول النبات وكذلك المحتوى المعدني للمجموع الخضري لنبات الخس تم الحصول عليها عند إضافة حمض الفاليك بمعدل 13 كجم/الفدان.