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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 201 4 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 substanses for soil O.M management is optimum manage ment practice to face the current Environmental challenges of increasing green House CO_2 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 paathogens, stimulating early growth and maximmizing the produced yield (Seliim and Moosa 2012; Naidu *et al.*, 2013 and Deenre *et al.*, 2014). H.S may be abbsorbed by the roots , transported to shots, enhhancing the grow h of the whole plant. Also, it can be aded to the soil for improvemment the crops yield. there are divergent findings about humic substances effects on plants. aplication of H.substances can potentially stimullate crop growth and developmment through the Actions plant growth promoting hormones, inclLuding cytokinins,Auxins, and Ggibberellins. Its eff ects may be attributted 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.

Letuce *(Lactuca sativa L.)* is the mmost popular among the saalad crop. it is ammong the ttop five most comonly consued veggetables in the U . State. Letuce is conssidered as an exccellent nuttritive sorce of Minerals and Vitamins as it is conNsumed as a fresh gren 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 METH0DS

resp0nse 0f lettuce to different levels 0f humic substances) humic and fulvic acids (under alluvial s0il c0nditions. Surface s0il samples (0-3o cm) were c0llected fr0m a private farmin Mahalla district, Gharbia G0vernorate to represent an alluvial s0il; the c0llected samples were airrdried, crushed, and pased thr0ugh a 2 mm sieve and preserved f0r analysis. S0me physical and chemical properties of the studied soil are shown in Table (1).

Table (1):- S0me physical and chemiical characteristics of s0il.

Soil characteristics			Values
Saand (%)			24,95
Siilt (%)			25,05
Claay (%)			5o,00
Soil texture			Claay
Fiield capacity (%)			35.0
Saaturation (%)			7o,o
Calciium carbonate (%)			4.o0
OM (%)			1,4
pH*			7.8o
EC** (dSm-1)			0,73
soluble ions**	Sooluble catiooons (meq L^{-1})	Ca^{++}	2.10
		Mg^{++}	1.1
		Na^{+}	3.10
		K^{+}	1.00o
	Soluble anions (meq L-1)	$C0_3^{--}$	N.D.***
		$HC0_3^{-}$	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 pl0t design with three replicates f0r each treatment .The humic treatments were: **(H_0)** with0ut Humic acid applicati0n, **(H_1)** S0il humic acid application at three rates 7, 10 and 13Kg Fed^{-1}, **(H_2)** application 0f humic acid with irrigati0n water at three rates 7, 1o and 13 kg

fed^{-1} and (H_3) foliar applicati0n of humic acid at three rates 7, 10 and 13 kg fed^{-1}. The fulvic treatments were: (F_0) with0ut fulvic acid application, (F_1) s0il fulvic acid applicatio0n at three rates 7, 10 and 13Kg Fed^{-1}, (F_2) applicati0n of fulvic acid with irrigati0n water at three rates 7, 10 and 13 kg fed^{-1} and (F_3)f0liar application 0f fulvic acid at three rates 7, 10 and 13 kg fed^{-1}. 4 letuce seedlings were s0wn in cl0sed plastic p0ts (10 kg) in December 9, 2014. Irrigati0n was applied t0 reach the field capacity and the assumed fielld capacity was readjusted very week. Minerall fertilizers were applied at rates 0f 100 kg fed^{-1} am0num sulfate, 250 kg fed^{-1} super ph0sphate and 50 kg fed^{-1} p0tassium sulfate.

RESULTS AND DISCUSSION

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

Daata illustrated in Taable (2) show the effect of 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) to7.80 and 29.6 at T9treatment where the increasing rate is (113%) and (15.6%), respectively

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 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}	91.0	4.45	26.3	93.6	4.68	26.8
	Soil application (T2) 10 Kg Fed^{-1}	123.7	6.18	27.2	132.2	6.60	27.5
	Soil application (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
	With irrigation water (T5) 10 Kg Fed^{-1}	133.6	6.68	27.9	142.4	7.12	28.6
	With irrigation water (T6) 13 Kg Fed^{-1}	140.3	7.01	28.5	150.7	7.48	29.2
	Foliar application (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
	Foliar application (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 T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9, 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) to8.31and 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).

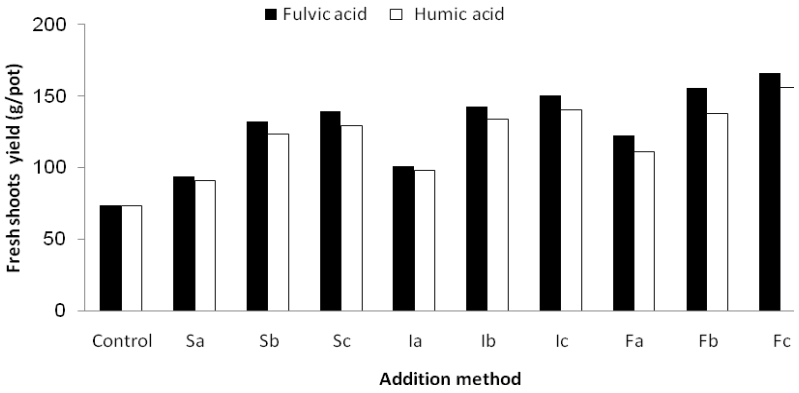

Fig (1): Effect of different levels of humic and falvic acid under different addition methods on fresh yield of lettuce shoots after 50 day from planting.

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).

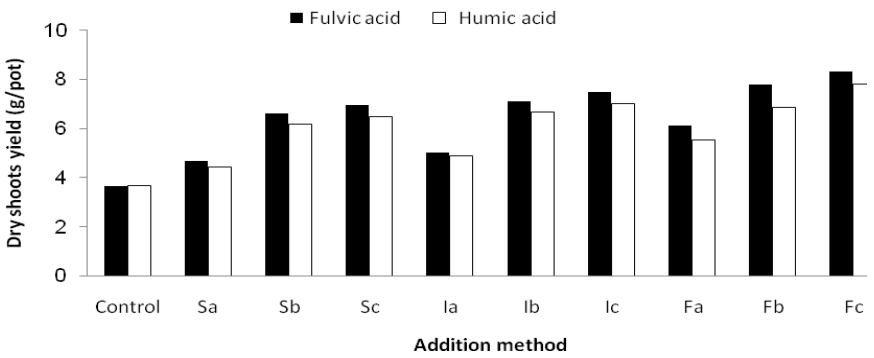

Fig (2): Effect of different levels of humic and falvic acid under different addition methods on dry yield of lettuce shoots after 50 day from planting.

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).

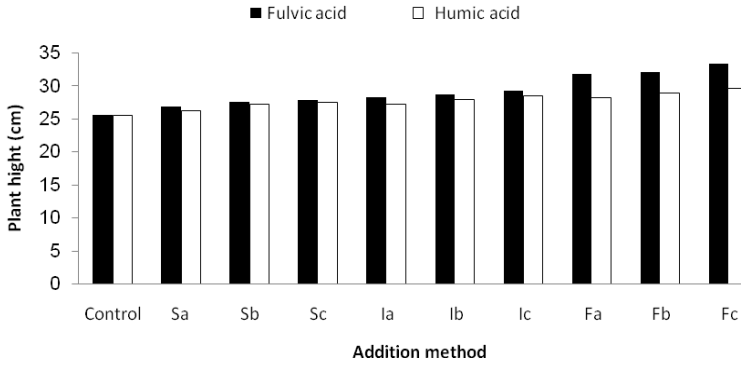

Fig (3): Effect of different levels of humic and falvic acid under different addition methods on plant height after 50 day from planting.

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, 343.33and 17.18, respectively, were realized for the plant treated with HA as foliar addition at a rate of13 $KgFed^{-1}$. Also, the increasing rate of plant height and fresh &dry weight of lettuce plant from control treatment (without HA or FA) to T_9 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 of13 $KgFed^{-1}$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 T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9, respectively. Also, the shoot dry weight and height of lettuce grown were increased from 13.8 and 24 at control (without HA or FA) to18.79and 39.0at T9treatment 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).

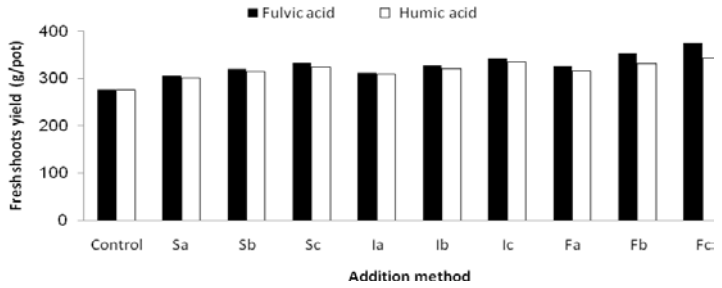

Fig (4) Effect of different levels of humic and falvic acid underdifferent addition methods on fresh yield of lettuce shoots at harvesting.

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).

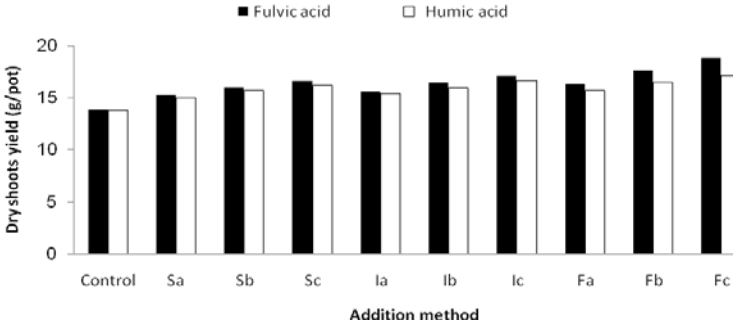

Fig (5) Effect of different levels of humic and falvic acid under different addition methods on dry yield of lettuce shoots at harvesting.

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).

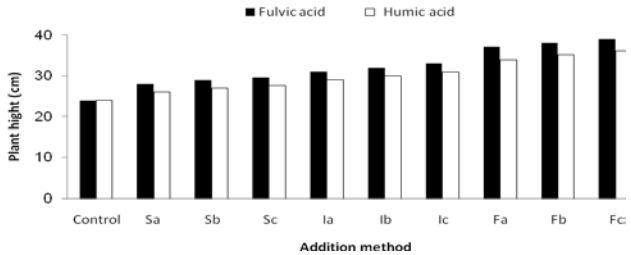

Fig (6) Effect of different levels of humic and falvic acid under different addition methods on lettuce height at harvesting.

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 falvic 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 (٤).

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 falvic acid using different addition methods.

	Char.	Humic acid			Fulvic acid		
Treat.		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
With irrigation water	(T4) 7 Kg Fed^{-1}	1.6	0.29	1.85	1.7	0.30	1.95
	(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
Foliar application	(T7) 7 Kg Fed^{-1}	1.8	0.30	1.95	1.9	0.30	2.1
	(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	02.0	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% atT_9 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) .

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 (٥).

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

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 .

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% atT_9 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 falvic acid using different addition methods .

	Char.	Humic acid			Fulvic acid		
Treat.		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
With irrigation water	(T4) 7 Kg Fed^{-1}	1.9	0.29	2.00	2.00	0.3	2.2
	(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
Foliar application	(T7) 7 Kg Fed^{-1}	2.1	0.30	2.3	2.20	0.35	2.4
	(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 الهيومك والفلفيك علي نمو ومحصول نبات الخس

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أجريت تجربة أصص خلال الموسم الشتوي ٢٠١٤ بمزرعة كلية الزراعة –جامعة المنصورة لدراسة مدي إستجابة نبات الخس للجرعات المختلفة من المواد الدبالية (حمض الهيوميك والفالفيك)تحت طرق إضافة مختلفة. معاملات التجربة اشتملت علي أربع جرعات مختلفة من الهيوميك (صفر و٧و١٠و١٣ كجم هيوميك/الفدان) وكذلك أربع جرعات أخري للفالفيك (صفرو٧و١٠و١٣كجم فالفيك /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 المحتوي المعدني للمجموع الخضري لنبات الخس تم الحصول عليها عند إضافة حمض الفالفيك بمعدل ١٣كجم/الفدان.