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EFFECT OF METHOD APPLICATION OF HUMIC ACID COMBINED WITH MINERAL N FERTILIZER ON SOIL FERTILITY AND FABA BEAN PRODUCTIVITY IN SANDY SOIL.

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ABSTRACT

A filed experiment was conducted at winter successive two seasons of 2012/2013 and 2013/2014 in the Farm of Ismalia Agriculture Research Station, (ARC), Ismalia Governorate, Egypt, to study the effect of different methods addition of humic acid on soil fertility and faba bean (Sakha 3) productivity. The experiment includes two methods of application (soil application at rates of 5 and 10 kg humic /fed) and foliar application at rates of (1 g and 2g humic /L water) alone or combined with mineral nitrogen fertilizer at rates of (0, 10, 20 and 30 kg N/fed) as ammonium nitrate (33.5 %N). The obtained results indicated that the effect of addition humic acid methods (soil application or foliar application) significantly increased growth character i.e. plant height (cm), No. of branch /plant, No. of pods/plant, weight of pods /plant (g) and weight of seed/plant (g) in both seasons. As well as, the methods used of humic acid (soil application or foliar application) at different rates had a significant effect on of seed yield (ton/fed), pods yield (ton/fed) and weight of 100 seeds (g) and chlorophyll, respectively, while the protein content was no significant in both seasons. Concerning the effect of humic acid application on N, P and K concentration in seeds were increased with increasing rates of humic 10 kg /fed and mineral N fertilizer 30 kg N/fed. The interaction between humic acid methods system application and different rates of mineral N were significantly increase for Fe in both seasons but no significant for Mn and Zn concentration in seeds faba bean plants. Also, the soil application of humic acid with 10 kg/fed and foliar application at a rate of 2g humic acid /L with 30 kg N led to highest available N, P and K content in soil after faba bean harvest compared with other treatments. On the other hand, the interaction between methods of humic acid application and different rates of mineral N fertilizer on Fe was significant in the first season and Mn in both seasons, while Zn was no significant in both seasons. It can be concluded that soil application of humic acid at rate 10 kg humic /fed and foliar application at rate 2g/L water had a favorable effect on yield and yield component and improve chemical constituents of faba bean and sandy soil.

Keywords: humic acid, Faba bean productivity, sandy soil, mineral nitrogen fertilizer.

INTRODUCTION

Humic acid is a commercial product contains many elements which improve the soil fertility and increasing the availability of nutrient elements and consequently affected plant growth and yield. Humic acid particularly is used to remove or decrease the negative effects of chemical fertilizers and some chemicals from the soil, (Hartwigson and Evans, 2000). Salman *et al.,* (2005) found that the availability of phosphate and iron increased due to humic application. Rajpar *et al.,* (2011) indicated that humic acid efficiently improves soil fertility and crop productivity, especially on poorly fertile soil. Mauromicale *et al.,* (2011) reported that the role of humic acid is well known in controlling, soil-borne diseases and improving soil health and nutrient

uptake by plants, mineral availability in soil. Mohamed *et al.,* (2009) reported that humic acid stimulate plant enzymes/hormones and improve soil fertility in an ecologically and environmentally benign manner. Darur et al (2008) studied the effect of different rates of nitrogen on dry matter and seed yield of faba bean were significant quadratic relation with the increasing N rates. Hamid *et al.,* (2011) reported that the without nitrogen fertilizer led to decreased values of seeds yield, plant height, 100 seed (g), No. of pod/plant and No. of seed/plant respectively. Prusiński (2007) reported that soil application with 30-90 kg N/ha as urea resulted in a significant increase in yield parameters, N concentration, and N uptake of faba bean plants. Maral (2012) indicated that interaction effect of humic acid and nitrogen management on seed yield, straw yield and harvest index showed significant differences at 5% probability level.

Faba bean (Vicia faba L.) is an important legume crop in Egypt and many parts of the world. It is popular food as it is used as green vegetable or fresh canned. Also, it is an important crop for soil improvement and is used as crop in cereal rotation to keep the soil fertile and productive through nitrogen fixation, (Mohammad *et al.,* 2011). Egyptian Government is pressing hard to increase the yield and quality of faba bean plant through improving agricultural practices such as fertilization to face the increasing demand of the population,(Ahmed et al 2003). Faba bean (Vicia faba L.) is an important legume crop in Egypt and many parts of the world. Its seeds exhibit high levels of protein (28–36 % of seed dry matter), (El-Kotb, 2013). Kocon (2010) found that broad bean yield increased by 14-15% when spraying with urea, compared to 2.4% at ground fertilization. Atere and Olayinka (2012) found that the low pH value obtained with the inorganic fertilizer application might be due to the acid-yielding property of urea fertilizer that served as the source of starter N. Bloom (2000) found that the urease-mediated reaction of soil-applied urea with H_2O results in rapid conversion to NH_4^+. In this reaction, H^+ ions are consumed and NH_4^+ and HCO^-_3 are produced, causing the soil pH, at the reaction site to increase. Adeyeye et al (2014) indicated that the application of N- fertilizer had no significant effect on all the growth parameters of soybean such as numbers of pods, number of seeds, seed weight and grain yield. Ahmed and Yassin (2013) stated that nitrogen plays an important role in plant growth and physiological processes, as it enters in all enzymes composition and enhances vegetative growth and yield.

The of this study investigate the growth, yield and components of faba bean plants and soil fertility as affect by soil application and foliar application of humic acid methods alone or combined with different mineral nitrogen rates fertilizer under sandy soil conditions.

MATERIALS AND METHODS

Two filed experiments were conducted at winter successive two seasons of 2012/2013 and 2013/2014 in the Farm of Ismalia Agriculture Research Station, (ARC), Ismalia Governorate, Egypt. The experiments were carried out to study the effect of methods of humic acid addition or foliar

combined with different rates of mineral nitrogen fertilizer on some macro-micronutrients in soil, faba bean productivity and macro-micronutrients concentration in seeds of faba bean (*Vicia faba* L.) variety Sakha 3. The experiment was laid out in a randomized complete block design with three replicates. The experiment was divided into two divisions; the first part was treated with humic acid mixed with sandy soil application for two rates at 5 and 10 kg humic acid mixed with 100 kg sandy soil. The applied of humic acid in same seedling plants day. Also, the second division was treated with humic acid foliar application for two rates of 1 and 2 g/L as well as foliar application after 21, 45 and 65 days after seeds sowing. Nitrogen fertilizer was added as ammonium nitrate (33.5 %N) with four rates (0, 10, 20 and 30 kg N fed^{-1}) in three times 21, 45 and 65 days after seeds planting.

Some physical and chemical properties of the experimental soil were shown in Table (1) according to Page *et al* (1982) and Cottenie *et al.,* (1982).

Table (1) Some physical and chemical properties of the studied soil before planting:

Coarse sand (%)	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Soil Texture**		**OM (%)**		**$CaCO_3$ (%)**
10.67	75.64	4.86	8.83	Loamy sand		0.55		1.68
pH (1:2.5)	EC* (dSm^{-1})	Cations (meq/l)				Anions (meq/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO^{-}_3	Cl^{-}	SO^{--}_4
8.03	1.79	4.58	2.44	10.13	0.75	2.85	6.37	8.68
Available macronutrients (mg/kg)			Available micronutrients (mg/kg)					
N	P	K	Fe	Mn	Zn			
37.95	3.55	182	1.38	1.35	0.49			

All farming processes were carried out before planting. Super phosphate (15.5 % P_2O_5) was applied ate a rate of 100 kg super phosphate fed^{-1} during tillage of soil. Seeds of faba bean were sown in 21 November in both seasons. Each experimental plot unit was 50 m^2 / fed (5 m width and 10 m long) at row to row distance of 50 cm. Two to three of seeds were sown in holes was 20cm. After 21 day of sowing, the plants of each hole were thinned to one plant. Potassium sulphate (48 % K_2O) was applied at a rate of 50 kg fed^{-1} on two equal doses after 20 and 40 days from sowing.

Soil samples were collected from all studied treatments at a depth of (0 – 30 cm) to determine some soil physical and chemical characteristics. Soil pH was determined in 1:2.5 soil: water suspensions according to the standard method of Richards (1954). Total soluble salts were measured in soil paste extract as described by Jackson (1973). Nitrogen was determined by kjeldahl method (Page et al, .1982). Phosphorus was determined colorimetrically and potassium was determined using flame- photometer according to Jackson (1973). Available micronutrients were extracted by DTPA (Soltanpour and Schwab 1977) and determined using Atomic Absorption Spectrophotometer.

Plant analysis : samples of faba bean seeds were oven dried at 70Co , crushed then wet ashed using of H_2SO_4 + $HCLO_4$ acids, then in aliquots of digested solution, P, K, Fe, Mn and Zn (mg kg^{-1}) , were determined (Soltanpoure, 1985). Total N content in seeds was determined by using micro-kjeldhl and protein was calculated by multiplying N content by 6.25 according to Chapman and Pratt (1961). Protein percentage of seeds was calculated by multiplying the nitrogen percentage by the factor 6.25 described by Hymowitz, *et al* (1972).

Random samples of ten plants were collected at 70 days after sowing from each plot to measure total chlorophyll. Photosynthetic total chlorophyll was estimated in fresh leaves as described by Witham et al. (1971).

All the data were subjected to an analysis of variance using the statistical analysis method described by Snedecor and Cochran (1990).

RESULTSAND DISCUSSION

Effect of methods application of humic acid on faba bean plants characters in sandy soil:

Effect of humic acid added at a rates of (5 and 10 kg /fed) and foliar (liquid 1 and 2 g humic acid/L water) on plant height (cm) No. of branches /plant, No. of pods/plant, weight of pods /plant (g) and weight of seeds/plant (g) in both seasons are shown in Table 2. The highest mean values of all growth characters are obtained with soil treated with humic acid application by 10 kg humic acid /fed combined with 30 kg N/fed. Also, the relative increases of mean values are 9.18, 8.80, 10.10, 9.38, 3.81, 6.73, 13.76, 14.49, 6.22 and 7.21 % for plant height (cm) , No. of branches /plant, No. of pods/plant, weight of pods /plant (g) and weight of seeds/plant (g), respectively for soil application of humic acid with 10 kg compared with 5 kg humic acid/fed. On the other hand, the highest mean values of plant height (cm), No. of branches /plant, No. of pods/plant, weight of pods /plant (g) and weight of seeds/plant (g) in plots treated with 2g humic /L in both seasons. The corresponding relative increase of mean values were 1.38, 1.32, 10.00, 1.60, 4.51, 9.90, 13.89 and 9.57 % for plant height (cm), No. of branches /plant, No. of pods/plant, weight of pods /plant (g) and weight of seeds/plant (g), respectively, as affected plant treated with foliar application (liquid) 2g/L compared with 1g/L. The addition of humic acid significantly, (soil application or foliar application) increased all the studied growth characters i.e. plant height (cm), No. of branches /plant, No. of pods/plant, weight of pods/plant (g) and weight of seeds/plant (g) in both seasons. Meanwhile, the different mineral nitrogen rates were significantly increased all plant growth characters except No. of branches /plant in the first seasons and No. of pods/plant in the second season.

Concerning the interaction between methods of humic acid application and different rates of mineral nitrogen were significant increase on plant height and No. of pods/plant in both seasons, except No. of branch was no significant in first season and weight of pods /plant (g) in the second season as well as the effect of interaction between humic acid methods and

different rates of mineral N fertilizer were no significant on the weight of seeds/plant (g) in both seasons.

Table 2. Effect of methods of humic acid application combined with different rates of N fertilization on plant growth .

Treatments	Rates of N kg fed^{-1}	Plant height (cm)		No. of branches/plant		No. of pods / plant		Weight of pods /plant (g)		Weight of seeds /plant (g)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
5 kg /fed humic acid	0	55.37	56.17	3.45	3.58	8.35	8.45	25.63	26.49	22.47	22.57
	10	64.85	68.21	4.52	4.66	9.72	9.78	28.41	30.52	23.64	23.86
	20	73.29	75.49	5.18	5.38	10.48	10.86	33.48	34.98	24.39	24.55
	30	77.10	78.36	6.25	6.42	11.35	11.93	34.29	36.10	24.75	24.96
Mean		67.65	69.56	4.85	5.01	9.98	10.26	30.45	32.02	23.81	23.99
10 kg /fed humic acid	0	55.86	56.93	3.78	3.75	8.66	8.79	27.55	30.28	23.14	23.54
	10	73.98	77.39	4.88	4.95	9.89	10.55	34.29	35.66	24.48	24.94
	20	79.48	80.22	5.68	5.88	10.55	11.63	36.21	38.52	26.35	26.75
	30	86.10	88.19	7.00	7.32	12.34	12.84	40.52	42.19	27.18	27.66
Mean		73.86	75.68	5.34	5.48	10.36	10.95	34.64	36.66	25.29	25.72
1g/L	0	55.78	56.82	3.41	3.52	6.75	6.88	24.10	24.74	21.51	21.66
	10	70.26	71.33	4.39	5.14	7.39	7.95	28.36	30.62	22.64	22.89
	20	72.93	73.46	4.90	5.49	7.86	8.04	30.59	31.16	23.18	23.55
	30	73.64	74.69	5.68	6.12	8.00	8.15	33.29	33.85	23.66	23.87
Mean		68.15	69.08	4.60	5.07	7.50	7.76	29.09	30.09	22.75	22.99
2g/L	0	55.93	56.88	3.56	3.60	6.79	7.21	26.39	29.41	23.55	23.75
	10	71.43	72.86	4.88	5.12	7.58	7.88	30.55	33.51	24.61	24.86
	20	73.59	74.21	5.36	5.88	7.98	8.34	33.69	35.22	25.85	25.99
	30	75.42	76.00	6.42	6.59	8.13	9.00	37.25	38.79	25.98	26.17
Mean		69.09	69.99	5.06	5.30	7.62	8.11	31.97	34.23	25.00	25.19
L.S.D. 5%Methods		1.36	1.32	0.48	0.012	0.29	2.84	0.85	1.22	0.88	1.06
L.S.D. Rate N		0.41	0.91	ns	0.014	0.40	ns	1.74	0.94	1.80	1.03
Interaction R XM		**	**	ns	**	**	**	*	ns	ns	ns

The relative increases of mean values 3.11 and 4.44% for plant height; 5.49 and 1.16% for No. of branches; 34.52 and 33.65% No. for pods/plant; 6.60 and 6.78 % for weight of pods /plant and 2.83 and 3.18 % for weight of seeds/plant in the first and second seasons respectively as affected by humic acid application methods compared with foliar application method system. These results are in agreement with El-Bassiony *et al.* (2010) who showed that foliar application by humic acid (at 1, 2 or 3 g/L) , significantly affected on all the vegetative growth parameters, i.e. plant height, number of leaves and branches as well as fresh and dry weight of whole snap bean plants (Phaseolus vulgaris, L.) cv. Paulesta grown under sandy soil conditions comparing with control plants. Kaya *et al.* (2005) mentioned that foliar application of common bean by humic acid at 2000 ml/ha, significantly increased number of seeds/plant and seed weight/plant.

Effect of different methods of humic acid addition on yield and yield components:

Data in Table 3 show that the methods used of humic acid (soil application or foliar application) at different rates had a significant effect on seeds yield (ton/fed), pods yield (ton/fed) and weight of 100 seeds (g) and chlorophyll, respectively, while the protein was no significant in both seasons. The highest mean values of seeds yield (ton/fed), pods yield (ton/fed) and weight of 100 seeds (g) , protein and chlorophyll were obtained by 10 kg/fed humic acid application compared with other treatments. The increase of all parameters of faba bean plants was carried out with the increase of humic acid rate (10 kg/ fed) application and foliar humic rates of 2g/L combined with increase of mineral nitrogen fertilizer rate. These results are in agreement with Shafeek *et al* (2013) and Abdel-Razzak and El-Sharkawy (2013) who found that the foliar spraying rates of humic acid (4g/L) recorded the high values of total yield and pods yield of borad bean and could be attributed to presence of plant growth regulators and increased activity of microbes. Antoun et al (2010) reported that application of humic acid in combination with the highest rate of N–fertilizer led to increase values of yield and its components of wheat plant. Results in Table 3 show that the effect of mineral nitrogen fertilization at different rates were significant affected on seeds yield (ton/fed), pods yield (ton/fed), weight of 100 seeds and protein (%) respectively, while chlorophyll content was no significant in both seasons.

Table (3). Yield and yield components of faba bean

Treatments	Rates of N kg fed^{-1}	Seed yield (ton/fed)		Pods yield (ton/fed)		Weight of 100 seeds		Protein (%)		Chlorophyll (a+b) mg/g f.w.	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
5 kg /fed humic acid	0	0.472	0.472	0.761	0.778	54.68	54.88	18.44	19.00	2.45	2.48
	10	0.794	0.819	0.986	0.995	56.47	57.31	20.81	22.38	3.74	3.78
	20	0.879	0.894	1.063	1.134	59.27	59.94	21.13	22.88	3.82	3.86
	30	0.918	0.961	1.149	1.185	61.43	62.10	21.44	23.19	3.98	4.10
Mean		0.770	0.790	0.990	1.020	57.96	58.56	20.44	21.88	3.50	3.56
10 kg /fed humic acid	0	0.489	0.495	0.785	0.794	55.75	55.96	18.63	19.31	2.58	2.66
	10	0.861	0.879	1.034	1.188	61.55	62.47	21.63	22.69	3.86	3.92
	20	0.993	0.996	1.274	1.296	63.75	64.25	22.38	23.19	3.97	4.10
	30	1.154	1.178	1.596	1.695	68.72	68.99	22.69	23.63	4.12	4.26
Mean		0.870	0.890	1.170	1.240	62.44	62.92	21.31	22.19	3.63	3.74
1 g/L	0	0.469	0.471	0.796	0.817	53.48	53.74	18.38	18.63	2.36	2.45
	10	0.739	0.785	0.983	0.998	54.96	55.62	20.19	21.06	3.24	3.55
	20	0.842	0.896	1.085	1.125	56.84	57.25	20.56	21.19	3.36	3.62
	30	0.895	0.934	1.159	1.166	58.21	59.34	21.00	21.56	3.45	3.77
Mean		0.740	0.770	1.010	1.030	55.87	56.49	20.06	20.63	3.10	3.35
2g/L	0	0.481	0.492	0.843	0.850	54.12	54.44	18.56	18.69	2.44	2.49
	10	0.789	0.819	0.988	1.023	58.74	59.63	20.81	21.25	3.58	3.65
	20	0.941	0.966	1.159	1.169	59.89	60.47	21.13	21.69	3.76	3.84
	30	0.998	0.975	1.185	1.197	61.33	62.76	21.63	22.13	3.89	3.97
Mean		0.800	0.810	1.040	1.060	58.52	59.33	20.56	20.94	3.42	3.49
L.S.D. 5% Methods		0.039	0.044	0.040	0.035	1.92	1.32	ns	ns	0.43	0.55
L.S.D. Rate N		0.047	0.040	0.056	0.031	1.32	0.91	5.50	5.50	ns	ns
Interaction R XM		**	ns	**	**	ns	*	ns	ns	ns	ns

Effect of interaction between methods of humic acid and mineral N-fertilizer was significant in its effect on seeds yield (ton/fed) in the first season and pods yield (ton/fed) in both seasons, while the weight of 100 seeds (g) was significant in the second season. Effect of interaction between methods system of humic acid and mineral N- fertilizer was no significant as affect on protein (%) and chlorophyll content in plant. The relative increase of mean values were 12.99 and 12.66, 18.18 and 21.57, 7.73 and 7.45, 4.26 and 1.42, 3.71 and 5.06 % for seed yield (ton/fed), Pods yield (ton/fed), weight of 100 seeds (g) protein (%) and chlorophyll (a+b) mg/g f.w, respectively in the first and second seasons as soil treated with application of 10 kg humic acid/ fed compared with applied 5 kg humic acid. Also, the relative increase of mean values were 8.11 and 5.19, 2.97 and 2.91, 4.74 and 5.03, 2.49 and 1.50, 10.32 and 4.18 %, respectively in the first and second seasons for soil treated with foliar application at rate of 2 g humic acid/ L method compared with foliar application at rate of 1g humic acid/L. The relative increases of mean values were 6.49 and 6.33 % seed yield (ton/fed); 5.37 and 8.13 % for pod yield (ton/fed); 5.25 and 4.89 % for weight of 100 seed (g); 2.78 and 6.01 % for protein (%) content in seeds and 9.36 and 6.37 % for chlorophyll content in plant in the first and second seasons, respectively as affected by humic acid application method compared with foliar application method system. Comparison between the two methods of application humic acid and its impact on characters of faba bean, it was found that the addition of humic acid application was better than foliar application. These results are in agreement with El-Bassiony *et al.* (2010) who showed that foliar application by humic acid (at 1, 2 or 3 g/L) significantly affected on all the vegetative growth parameters, i.e. plant height, number of leaves and branches as well as fresh and dry weight of whole snap bean plants (Phaseolus vulgaris, L.) cv. Paulesta grown under sandy soil conditions comparing with control plants. Maral (2012) indicated that interaction effect of humic acid and nitrogen management on seeds yield, straw yield and harvest index showed significant differences at 5% probability level. On the other hand, the humic acid application at rate of 10 kg /fed combined with 30 kg N /fed gave the highest values of seeds yield/fed, pods yield /fed weight of 100 seeds , protein (%) and chlorophyll content in faba bean plants compared with other treatments. Hanafy *et al.* (2010) indicated that addition of humic acid, significantly increased chlorophyll a and total chlorophylls. The beneficial effect of humic acid on plant growth could be referred to its acting as a source of plant growth hormones. Humic acids are considered as an important source of organic matter and their effects on yield and its components could be through their enhancing effect on increase soil moisture holding capacity, improve soil texture as well as promote the uptake of nutrients leading to stimulation of plant growth (higher biomass production) and consequently on total pods yield and its components (Zhang *et al.,* 2003).

Macronutrients concentration in seeds of faba bean:

Effect of methods of humic acid systems addition on N, P and K concentration in seeds of faba bean plants are presented in Table 4. Concerning the effect of humic acid application on N, P and K concentration in seeds were increased with increasing rates of humic (10 kg /fed) and

mineral N fertilizer (30 kg N/fed). The effect of humic acid application methods (application or foliar) was significantly increase for N and K in both seasons, while the K concentration was no significant in the first season.

Table 4. Macronutrients concentration in seeds faba bean plant

Treatments	Rates of N kg fed^{-1}	N (%)		P (%)		K (%)	
		1st	2nd	1st	2nd	1st	2nd
5 kg /fed humic acid	0	2.95	3.04	0.38	0.39	2.36	2.38
	10	3.33	3.58	0.45	0.46	2.49	2.51
	20	3.38	3.66	0.49	0.51	2.52	2.55
	30	3.43	3.71	0.55	0.55	2.56	2.59
Mean		3.27	3.50	0.47	0.48	2.48	2.51
10 kg /fed humic acid	0	2.98	3.09	0.40	0.41	2.39	2.41
	10	3.46	3.63	0.47	0.50	2.54	2.58
	20	3.58	3.71	0.53	0.58	2.59	2.63
	30	3.63	3.78	0.57	0.62	2.64	2.66
Mean		3.41	3.55	0.49	0.53	2.54	2.57
1 g/L	0	2.94	2.98	0.35	0.37	2.36	2.38
	10	3.23	3.37	0.39	0.42	2.41	2.42
	20	3.29	3.39	0.42	0.45	2.45	2.47
	30	3.36	3.45	0.46	0.49	2.49	2.51
Mean		3.21	3.30	0.41	0.43	2.43	2.45
2g/L	0	2.97	2.99	0.39	0.41	2.39	2.43
	10	3.33	3.40	0.43	0.48	2.44	2.48
	20	3.38	3.47	0.47	0.53	2.48	2.52
	30	3.46	3.54	0.52	0.58	2.53	2.57
Mean		3.29	3.35	0.45	0.50	2.46	2.50
L.S.D. 5% methods of humic		0.35	0.22	0.021	0.027	ns	0.016
L.S.D. Rate N		ns	ns	0.019	0.014	ns	0.014
Interaction R XH		ns	ns	ns	ns	ns	**

As regards to the foliar application of humic acid system, was increase of N, P and K concentration in seeds of faba bean plants with increasing rates (humic acid 2g/L and 30 kg N/fed). On the other hand, the interaction between humic acid methods system and different rates of mineral N fertilizer no significantly effect on N and P concentration in seeds except K was significant in the second season. The relative increases of mean values were 2.77 and 6.02 % for N; 11.63 and 8.60% for P and 2.66 and 2.63 for K concentrations in seeds for the first and second seasons as affected by humic acid application compared with humic acid foliar application system. These results are in agreement with El-Ghamry et al.(2009) who found significant increases in N, P and K content in seed and straw of faba bean plants as response to humic acid added (at 1000, 2000 or 3000 ppm). Hanafy et al (2010) reported that humic acid application was significantly increased N, P and K content in snap bean.

Micronutrients concentration in seeds of faba bean plants.

Data presented in Table 5 show that the effect of humic acid application methods on Fe, Mn and Zn concentration in seeds was significant increase

with increasing rates. On the other hand, the effect of different rates of mineral N on Fe, Mn and Zn were significant increase with increasing rates. The interaction between humic acid methods system application and different rates of mineral N were significantly increase for Fe in both seasons but no significant for Mn and Zn concentration in seeds of faba bean plants. The relative increases of mean values were 10.69 and 11.55% for Fe; 8.48 and 9.85% for Mn and 6.71 and 10.60% for Zn concentration in seeds of faba bean plants in the first and second seasons, respectively, as affected by humic acid application system compared with humic acid foliar method.

Table 5. Micronutrients concentration in the seeds of faba bean plant

Treatments	Rates of N kg fed^{-1}	Fe (mgkg^{-1})		Mn (mgkg^{-1})		Zn (mgkg^{-1})	
		1st	2nd	1st	2nd	1st	2nd
5 kg /fed humic acid	0	75.63	76.19	46.98	47.05	17.16	18.67
	10	86.14	88.52	49.62	50.35	20.68	22.56
	20	89.29	90.36	53.14	54.69	22.53	24.79
	30	95.47	96.10	55.37	58.41	22.98	26.33
Mean		86.63	87.79	51.28	52.63	20.84	23.09
10 kg /fed humic acid	0	76.98	79.84	47.34	49.85	19.85	20.47
	10	92.17	93.55	55.47	57.63	24.36	26.88
	20	98.34	108.36	59.32	62.14	28.59	30.48
	30	114.36	119.45	62.48	67.35	30.14	34.29
Mean		95.46	100.30	56.15	59.24	25.74	28.03
1 g/L	0	69.88	70.52	44.62	45.19	16.48	17.17
	10	77.89	79.64	48.37	49.56	19.75	20.66
	20	82.14	84.23	50.44	53.17	21.37	22.43
	30	88.96	89.67	52.95	54.33	22.00	24.61
Mean		79.72	81.02	49.10	50.56	19.90	21.22
2g/L	0	72.19	73.55	45.68	46.85	18.74	20.08
	10	85.36	89.22	47.52	47.67	21.66	22.95
	20	88.75	91.43	52.19	53.22	25.84	26.74
	30	92.85	96.17	54.32	57.39	28.77	30.22
Mean		84.79	87.59	49.93	51.28	23.75	25.00
L.S.D. 5% methods		2.01	1.87	2.39	1.92	1.78	2.59
L.S.D. Rate N		2.42	3.24	1.73	1.93	2.63	3.89
Interaction R X M		**	**	ns	ns	ns	ns

These results are in agreement with Hanafy *et al* (2010) who reported that humic acid application was significantly increased Fe, Mn and Zn content in snap bean. Shafeek *et al.* (2013) found that humic acid application was significant increase in the accumulation of Fe, Mn and Zn in tissues of plants. Shehata *et al.* (2012) indicated that the spraying with humic acid (1.5 g/L) led to increase of nutrients accumulation in plants.

Effect of methods application of humic acid on Available nutrients in soil.

Available macronutrients in soil.

Data presented in Table 6 show that the soil application of humic acid with 10 kg/fed and 30 kg N fed led to the highest available N, P and K content

in soil after faba bean harvest compared with the other treatments. Also, the humic acid foliar application with 2g/L combined with 30 kg N/fed gave higher available N, P and K content in soil than foliar with humic acid alone. The effect of methods of application for humic acid on N and K contents in soil were significantly increased in both seasons, expect P in the first season was no significant. On the other hand, the different rates of mineral nitrogen were significant for N in first season and K content in both seasons, while P content in soil was no significant in first season. The interaction between method application of humic acid system and different rates of mineral N fertilizer on N, P and K content in soil were no significant affect. The relative increases of mean values were 4.02 and 4.16 % for N ; 5.94 and 6.80 % for P and 4.16 and 2.85 % for K content in soil in the first and second seasons, respectively as affected by humic acid soil application compared with foliar application method system. These results are in agreement with Mohammad et al (2014) who found that the humic acid substances on soil was the active constituent of organic humus and improve soil biologically, soil organisms and increase nutrients.

Table 6. Available macronutrients content in soil as affected by different methods of application the humic acid

Treatments	Rates of N kg fed^{-1}	N (mgkg^{-1})		P (mgkg^{-1})		K (mgkg^{-1})	
		1st	2nd	1st	2nd	1st	2nd
5 kg /fed humic acid	0	34.82	34.89	3.67	3.75	193.00	195.00
	10	36.59	36.99	3.89	3.95	198.00	203.00
	20	37.25	37.72	3.94	3.98	204.00	208.00
	30	37.86	37.93	3.99	4.03	209.00	213.00
Mean		36.63	36.88	3.87	3.93	201.00	204.75
10 kg /fed humic acid	0	34.98	35.00	3.72	3.73	196.00	199.00
	10	38.55	38.96	4.12	4.25	203.00	207.00
	20	39.42	39.76	4.36	4.41	208.00	214.00
	30	39.86	40.39	4.39	4.56	216.00	219.00
Mean		38.20	38.53	4.15	4.24	205.75	209.75
1 g/L	0	34.12	34.22	3.62	3.66	185.00	189.00
	10	35.61	35.78	3.67	3.72	189.00	197.00
	20	35.88	36.13	3.73	3.76	194.00	198.00
	30	36.10	36.55	3.79	3.83	198.00	205.00
Mean		35.43	35.67	3.70	3.74	191.50	197.25
2g/L	0	34.55	34.68	3.70	3.72	190.00	198.00
	10	35.87	36.10	3.88	3.93	197.00	204.00
	20	37.62	37.88	3.92	3.95	203.00	209.00
	30	37.99	38.24	3.98	4.05	206.00	212.00
Mean		36.51	36.73	3.87	3.91	199.00	205.75
L.S.D. 5% Methods		1.25	1.23	ns	0.20	3.27	1.92
L.S.D. Rate N		1.04	ns	ns	0.28	2.92	1.74
Interaction R XM		ns	ns	ns	ns	ns	ns

Available micronutrients in soil.

Effect of methods system application or foliar of humic acid on available Fe, Mn and Zn content in soil after faba bean harvest was positive effect.

Results were represented in Table 7. Methods of humic acid application and different rates of mineral N fertilizer were significant effect on Fe in the first season and Mn and Zn content of soil in both seasons. The interaction between methods of humic acid application and different rates of mineral N fertilizer on Fe was significant in the first season and Mn in both seasons, while Zn was no significant in both seasons. The positive effect of humic substances in increasing the availability of micronutrients may be due its priming effect to increase water soluble amounts of micronutrients after addition of humic substances, which led to chelating and subsequent release of micronutrients (Baris and Ali, 2013).

Table 7. Available micronutrients content in soil as affected by different methods application of humic acid

Treatments	Rates of N kg fed^{-1}	Fe (mgkg^{-1})		Mn (mgkg^{-1})		Zn (mgkg^{-1})	
		1st	2nd	1st	2nd	1st	2nd
5 kg /fed humic acid	0	1.96	1.98	1.43	1.45	0.59	0.62
	10	2.07	2.12	1.59	1.62	0.63	0.67
	20	2.15	2.18	1.66	1.68	0.68	0.75
	30	2.19	2.24	1.72	1.75	0.74	0.79
Mean		2.09	2.13	1.60	1.63	0.66	0.71
10 kg /fed humic acid	0	1.99	2.01	1.44	1.49	0.60	0.63
	10	2.09	2.14	1.68	1.75	0.68	0.75
	20	2.18	2.23	1.88	1.93	0.73	0.78
	30	2.23	2.28	1.93	1.98	0.79	0.86
Mean		2.12	2.17	1.73	1.79	0.70	0.76
1 g/L	0	1.92	1.95	1.37	1.38	0.52	0.53
	10	1.95	1.98	1.42	1.43	0.58	0.59
	20	1.98	2.00	1.47	1.48	0.60	0.63
	30	2.02	2.07	1.49	1.53	0.67	0.69
Mean		1.97	2.00	1.44	1.46	0.59	0.61
2g/L	0	1.94	1.98	1.39	1.40	0.54	0.56
	10	1.97	1.99	1.46	1.50	0.65	0.63
	20	2.05	2.09	1.52	1.56	0.70	0.66
	30	2.09	2.13	1.66	1.69	0.72	0.77
Mean		2.01	2.05	1.51	1.54	0.65	0.66
L.S.D. 5% humic		0.024	ns	0.015	0.024	0.030	0.023
L.S.D. Rate N		0.025	ns	0.011	0.024	0.024	0.006
Interaction R XH		**	ns	**	**	ns	ns

It was also reported that the addition of humic acid to a soil increased the available of Fe, Mn and Zn than foliar humic acid. The corresponding relative increases of mean values were 5.78 and 6.17 % for Fe, 12.88 and 14.00 % for Mn and 9.68 and 15.75 % for Zn available in soil in the first and second seasons, respectively, as affected by soil application of humic acid method compared with foliar application of humic acid method system. Differently

this result may relate to increasing microorganism activity in soil. The ability of humic acid to complex soil elements makes nutrients more available to microbes. Nardi et al. (2005) found that the humic acid substances are recognized as a key component of soil fertility properties, since they control chemical and biological properties of rhizosphere. Sharif *et al.,* (2002) found that the indirect influences of humic acids on plant growth because they can improve soil properties such as aggregation, aeration, permeability, water holding capacity, hormonal activity, microbial growth, organic matter mineralization and solubilisation and availability of microelements (Fe, Zn and Mn) elements .

CONCLUSION

These results show that addition methods of soil application and foliar application humic acid were effective for plant growth. As a conclusion, added of 5 and 10 kg /fed rate of humic acid and 1 g/L and 2g /L were found more effective doses with related to availability of macro-micronutrients in soil. However, applications of soil application and foliar of humic acid methods at relationship soil properties with faba bean growth and nutrient uptake of plant were found more effectively than foliar application.

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تاثير طرق اضافة حمض الهيوميك المتحد مع التسميد النيتروجينى على خصوبة التربة وانتاجية الفول البلدى فى أرض رملية

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أجريت تجربتان حقليتان لموسمين شتوين 2013/2012 و 2014/2013 فى مزرعة محطة البحوث الزراعية بالاسماعيلية مركز البحوث الزراعية محافظة الاسماعيلية . لدراسة تاثير طرق اضافة حمض الهيوميك على تحسين بعض صفات التربة الرملية وانتاجية الفول البلدى صنف سخا 3 .تأثير طرق الاضافة كانت حمض الهيوميك ارضى بمعدلات 5 و10 كجم حمض هيوميك مخلوط مع الرمل والطريقة الثانية اضافة حمض الهيوميك رش بمعدل 1 و 2 جرام حمض الهيوميك لكل لتر ماء منفردة أو متحدة مع معدلات مختلفة من التسميد النتروجينى (مصدر نترات النشادر5 .33 % .

وقد اوضحت النتائج ان:

تاثير طرق اضافة حمض الهيوميك (اضافة أرضية أو الرش) كان لة تاثير معنوى على صفات النمو طول النبات ، عدد الفروع للنبات الواحد ، عدد القرون للنبات ، وزن القرون للنبات (جرام) ووزن الحبوب لكل نبات (جرام) لكلا الموسمين. كذلك استخدام كلا الطريقين لاضافة حمض الهيوميك (اضافة ارضية واضافة بالرش) بمعدلات مختلفة أدى الى زيادة معنوية فى محصول الحبوب للفدان، محصول القرون للفدان، وزن 100 حبة والمحتوى الكلى للكلوروفيل على التوالى بينما كان تاثيرهم على محتوى البروتين فى البذور غير معنوى فى كلا الموسمين. وجد ان اضافة المعدل الاعلى من حمض الهيوميك (10 كجم للفدان او 2جرام لكل لتر ماء + 30 كجم نتروجين) ادى الى زياده فى محتوى البذور من العناصر الكبرى النتروجين والفوسفور والبوتاسيوم

لوحظ ان اتحاد طرق اضافة حمض الهيوميك مع معدلات التسميد النبتروجينى ادى الى زيادة محتوى العناصر الصغرى الحديد والمنجنيز والزنك فى بذور الفول البلدى .

وجد ان الاضافة الارضية بمعدل 10 كجم حمض الهيوميك و الاضافة رشا بمعدل 2 جرام لكل لتر ماء ادى الى زياده تيسر العناصر الكبرى النتروجين والفوسفور والبوتاسيوم فى التربة بعد حصاد الفول البلدى بالمقارنة بباقى المعاملات.

ومن ناحية اخرى لوحظ ان التفاعل بين معدلات التسميد النتروجينى وطرق اضافة حمض الهيوميك كان معنويا على عنصر الحديد فى الموسم الاول و المنجنيز فى الموسمين بينما الزنك الميسر فى التربة كان غير معنويا فى الموسمين.

يمكن ان نلخص النتائج السابقة من الدراسة ان طرق الاضافة الارضية لحمض الهيوميك بمعدل 10 كجم هيومك و 2 جرام حمض الهيوميك لكل لتر رشا كان لة تاثير ايجابى على المحصول والمحتوى العناصر وتحسين بعض المكونات الكميائية فى الفول والتربة الرملية.