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YIELD AND NUTRIENT UPTAKE OF SOME FABA BEAN VARIETIES GROWN IN NEWLY CULTIVATED SOIL AS AFFECTED BY FOLIAR APPLICATION OF HUMIC ACID

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ABSTRACT

Two field experiments were conducted in sandy soil under salinity conditions in El-Emam El-Ghazaly Village, South El-Tahrir Province, El-Behaira Governorate, Egypt, during the two winter successive seasons 2006/2007 and 2007/2008 using three faba bean (*Vicia faba* L.) varieties, namely: Giza-461, Giza-3, Giza-429, to study the effect of foliar spray of commercially produced humic acid 2.9%, containing N,P,K (10,10,10%) used during the growing season at concentrations of 0, 5, 10, 20 cm/l on yield and yield components as well as nutrient uptake in faba bean seeds. There were significant differences between treatments and control for seed yield, biological yield and harvest index. The reaction between the treatments and the varieties showed that foliar application of humic acid for Giza-461 at concentration of 20 cm/l enhanced the number and weight of pods and straw as well as seed, biological yield. All treatments of humic increased the nutrient uptake more than control. The highest N uptake was attained with 20cm/l and the highest Fe and Mn uptake was with 5 cm/l. The highest uptake of nutrients as affected by humic foliar application was obtained from 20 cm/L with Giza-461, from 5 cm/L with Giza-3 and 10 cm/L with Giza-429. It seems that foliar application of humic acid under such conditions is more effective in improving seed nutrient uptake and yield of faba bean varieties under study.

Keywords: Faba bean (*Vicia faba* L.), humic acid, foliar application, nutrients uptake, yield.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important food crops in Egypt. It is considered one of the main sources of plant proteins for human nutrition in Egypt. It covers a considerable part of protein although its production is insufficient to meet the total demand in the country. High yield production of faba bean is urgently needed to meet the increasing population and growing demand for protein food in Egypt. According to Central Agency for Public Mobilization and Statistics (1996), its yields are still below the potential of its modern cultivars. Continuous efforts are carried out to improve its productivity, especially in newly reclaimed areas which have low nutrient contents, high pH, low organic matter content and high salinity. Legumes are among the crops whose yields are limited under such conditions (Sillanpää, 1982, El-Fouly *et al.*, 1984, Hafiz & El-Kholy, 2001).

Humic substances are well known as complexing agents for transition metal cations, thereby facilitating enhanced nutrients uptake (Chen *et al.*, 2001).

There are a few studies on using humic acid as foliar application, although previous studies in the literature have shown that humic acid as foliar sprays enhanced growth, nutrient uptake and yield in some crops

(David 1991, El-Desuki 2004, Delfine *et al.*, 2005, Mani Sangeetha *et al.*, 2006, Ramasamy Natesan *et al.*, 2006).

The soil of the South El-Tahrir sector is sandy in textures which have low nutrient contents. Further information is needed on humic acid effect on yield of faba bean. Thus, the objective of this work was to study if humic acid when used as a foliar application can improve yield and seed nutrient uptake of some faba bean varieties grown in newly reclaimed areas.

MATERIALS AND METHODS

Two field experiments were carried out in El-Emam El-Ghazaly Village, South El-Tahrir Province, El-Behaira Governorate, Egypt, during two winter consecutive seasons (2006/2007 and 2007/2008) The trials were performed on three faba bean (*Vicia faba* L.) varieties: Giza-461, Giza-3 and Giza-429, humic acid 2.9% containing N,P,K (10,10,10%) was used in this work. Soil surface samples (0-30 cm depth) were taken before sowing from the experimental site. Soil was air-dried and sieved through 2mm pores sieve for determination of, Physic-chemical characteristics. According to the tentative values of soil characteristics and available nutrient concentrations, data presented in Table (1) reveal that the experimental soil is sandy in texture, tented to alkalinity in reaction. It had low content of calcium carbonate, very low in organic matter, E.C and Na were high. Low in phosphorus, potassium and magnesium as well as micronutrients, Seeds of faba bean varieties were inoculated prior to sowing with the specific strain of Rhizobium Leguminosarum and were sown at the rate of 75 Kg/ fed, on 15th November during the two growing seasons. Phosphorus was applied to soil before planting at the level of 31 Kg P_2O_5/fed as calcium super phosphate (15.5% P_2O_5). Nitrogen was applied at the level of 30Kg N/fed as ammonium sulphate 20.6% N at the beginning of tillering, while potassium was added as potassium sulphate (48% K_2O) at a rate of 24 Kg K_2O/fed during pod filling. Foliar application with humic acid 2.9% was done at 40 days after sowing with a rate of 200 litre of solution/fed. The plants were irrigated by sprinkler irrigation from water having pH 7.15 and EC 1.37 dS/m.

Table 1: Soil physico- chemical characteristics of the experimental farm.

Character		Available nutrients	
Sand %	86.00	(mg /100g)	
Silt %	11.00	P	00.85 L
Clay %	03.00	K	05.01 VL
Soil Texture	Sandy	Mg	15.00 L
pH	07.47 H	Ca	140.00 L
EC dS/m	01.87 H	Na	60.00 H
$CaCO_3$ %	01.98 L	(mg/Kg)	
O.M %	00.44 VL	Fe	07.40 L
		Mn	06.50 L
		Zn	01.28 L
		Cu	00.80 L

VL = very low, L = Low, M = Moderate, H = High according to Ankerman and Large (1974)

The different soil features were determined as follows:
Texture: Hydrometer method (Bouyoucos, 1954).
pH and EC: in 1:2.5 soil/water suspension (Chapman and Pratt, 1978).
$CaCO_3$: Collin's calcimeter (Alison and Moodle, 1965).
O.M: Black method (Isaac and Johnson, 1984).
P: NaHCO3 extraction at pH 8.5 (Olsen *et al.*, 1954).
K, Ca and Mg: NH4-OAc extraction at pH 7 (Jackson, 1973).
Fe, Mn, Zn and Cu: DTPA extraction at pH 7.3 (Lindsay and Norvell, 1978).
Four treatments of humic acid were tested as follows:

1. Control (without foliar application of humic acid)
2. Humic acid at concentration of 05cm/ l of water
3. Humic acid at concentration of 10cm/ l. of water
4. Humic acid at concentration of 20cm/ l. of water

Treatments were arranged in a split plot design with three replicates. Varieties occupied the main plots and humic treatments were allocated at random in the sub plots, each plot was 10.5 m^2 in area (1/400 fed).

Ten-guarded plants were taken randomly from each plot for all treatments to determine plant height, number of branches and pods, weight of pods and seeds. At full maturity all plants from each plot of the different treatments and varieties were collected to estimate seed and straw yield.

Total N was determined in the dry seeds using Kjeldahl method; total P was photo metrically determined using molybdate-vanadate method, while, total K, Ca and Na were determined using flame photometer. Micronutrients and magnesium was measured using atomic absorption spectrophotometer, according to Chapman and Pratt (1978)

The data were statistically analyzed as split plot design according to Snedecor and Cochran (1980). Comparisons among means of treatments were tested for significance against L.S.D values at 5% level of probability proposed by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Yield Components

Data presented in Table 2 exhibited that Giza 429 was the highest in plant height, number and weight of pods/plant and straw yield, while Giza 3 was the lowest in the most of characteristics. As for effect of foliar sprays of humic acid on yield and its components, Table 3 showed that there were significant differences between treatments and control for seed yield, biological yield and harvest index whereas no significant differences found between treatments and control for plant height, number of branches, number and weight of pods/plant and straw yield. However, data presented in Table 4 show that foliar application of humic acid for Giza-461 at concentration of 20 cm/l enhanced the number, weight of pods and straw as well as seed and biological yield.

Table 2: Effect of varieties on growth characters, yield and yield components of faba bean. (Combined analysis of two seasons)

Variety \ Character	Plant height (cm)	Number of Branches/plant	Weight of pods (g/plant))	Number of pods/plant	Weight of seeds (g/plant)	Straw yield (g/plant)	Seed index	Seed yield (Kg/fed)	Straw yield (Kg/ fed)	Biological yield (Kg/fed)	Harvest index
Giza-461	55.7	3.8	45.7	14.5	31.8	11.6	84.4	1272.8	469.7	1742.5	0.728
Giza-3	49.3	2.9	35.0	9.9	28.1	9.7	81.4	1121.9	387.7	1509.6	0.741
Giza-429	62.1	3.6	51.1	17.9	30.3	13.8	85.2	1212.6	550.1	1762.7	0.688
LSD 5%	1.94	0.27	2.14	0.59	1.61	0.60	3.50	64.32	24.15	97.24	0.032

*** Feddan = 0.42 ha**

Table 3: Effect of foliar sprays of humic acid on growth characters, yield and yield components of faba bean (Combined analysis of two seasons)

Treatment \ Character	Plant height (cm)	Number of Branches/plant	Weight of pods (g/plant))	Number of pods/plant	Weight of seeds (g/plant)	Straw yield (g/plant)	Seed index	Seed yield (Kg/fed)	Straw yield (Kg/ fed)	Biological yield (Kg/fed)	Harvest index
Control	56.2	3.8	45.2	13.8	24.0	12.0	84.9	958.1	480.4	1438.5	0.672
5 cm humic acid/l	53.6	3.4	44.7	12.4	32.3	11.6	84.9	1292.0	465.0	1757.1	0.734
10 cm humic acid/l	57.2	3.4	42.0	15.3	31.9	11.5	84.2	1274.2	465.9	1740.1	0.739
20 cm humic acid/l	55.7	3.2	43.7	14.8	32.1	11.6	80.6	1285.2	465.5	1750.7	0.730
LSD 5%	1.95	0.51	3.17	1.54	2.11	0.71	7.35	84.15	28.65	112.80	0.032

*** Feddan = 0.42 ha**

Table 4: Effect of interaction treatments on vegetative growth and yield of faba bean (Combined analysis of two seasons)

Variety	Treatment	Plant height (cm)	Number of Branches/plant	Weight of pods (g/plant))	Number of pods/plant	Weight of seeds (g/plant)	Straw yield (g/plant)	Seed index	Seed yield (Kg/fed)	Straw yield (Kg/ fed	Biological yield (Kg/fed)	Harvest index
Giza-461	Control	57.0	4.2	48.5	15.2	26.7	13.2	80.6	1066.8	527.6	1594.4	0.669
	5 cm humic acid/l	49.0	3.5	36.0	10.8	28.1	10.1	87.3	1124.8	404.8	1529.6	0.735
	10 cm humic acid/l	56.7	3.7	40.5	13.6	30.1	9.33	83.8	1204.4	393.2	1597.6	0.754
	20 cm humic acid/l	60.0	3.7	57.6	18.2	42.4	13.8	86.1	1695.2	553.2	2248.4	0.754
Giza-3	Control	45.0	3.3	27.0	7.7	20.6	7.8	83.3	823.6	311.2	1134.8	0.726
	5 cm humic acid/l	51.8	3.3	44.1	8.3	38.6	12.8	84.4	1544.4	512.0	2056.4	0.751
	10 cm humic acid/l	50.0	2.5	36.8	14.7	29.1	8.2	81.4	1164.2	326.0	1490.2	0.781
	20 cm humic acid/l	50.5	2.5	31.9	9.0	23.9	10.0	76.3	955.2	401.6	1356.8	0.704
Giza-429	Control	66.7	3.8	60.0	18.5	24.6	15.1	90.8	984.0	602.4	1586.4	0.620
	5 cm humic acid/l	60.0	3.3	53.9	18.0	30.2	12.0	82.9	1207.2	478.0	1685.2	0.716
	10 cm humic acid/l	65.0	4.0	48.8	17.7	36.4	17.0	87.5	1454.0	678.4	2132.4	0.682
	20 cm humic acid/l	56.7	3.3	41.7	17.3	30.1	11.0	79.5	1205.2	441.6	1646.8	0.732
LSD 5%		3.89	0.54	4.28	1.19	3.22	1.20	7.0	128.6	48.29	194.5	0.064

*** Feddan = 0.42 ha**

Concerning the positive effect of humic on yield, Castro *et al.* (1988) found that humic acid applied as foliar sprays at 1 quart/acre greatly increased the yield of extra large fruits of tomato, Chen and Aviad (1990) suggested 0.45 lb/ acre as the minimum amount of foliar applied humic acid to elicit an increase in crop productivity. Also, Hu and Wang (2001) mentioned that KOMIX, humic acid used as soil treatment or as spray at the seedling stage significantly increased the yield, seeds per plant, pods per plant, seed weight per plant, 100-seed weight and chlorophyll content of springing soybean plants. Also, promoted the growth and developments of spring soybean plants.

The increase in seed yield may be due to hormonal effect of humic acids that improve the nutrient status of plants. Chen and Aviad, (1990) pointed out that humic are important for plant growth hormones. Dorneanu *et al.* 2008, reported that humic acids enhance the penetration of nutritive ions in leaves, stimulate the formation of some physiologically active metabolite compounds, enlarge the capacity of plants for root absorption of elements from soil.

Seed nutrient uptake

Results in Table 5 showed that foliar application of humic acid resulted in the highest uptake of Mg and Mn, for Giza-461. The lowest uptake of N and Ca was observed for Giza-429. On opposite, the uptake of P was the highest in the same variety. Regarding the uptake of Zn and Cu, Giza-3 was the lowest whereas was the highest for Fe. On the other hand, there is no difference of significant found between all varieties with respect to seed K uptake. The data in Table 6 showed that all treatments of humic increased the nutrients uptake over control. The highest N uptake was attained with 20cm/l and the highest Fe and Mn uptake was recorded with 5 cm/l.

The highest uptake of nutrients as affected by humic foliar application and faba bean varieties was obtained from 20 cm/L with Giza-461, from 5 cm/L with Giza-3 and 10 cm/L with Giza-429, (Table7).

In this respect, Chiu (1990) mentioned that iron is required for several key enzymes in legumes, and for this reason, all legumes have a high iron requirement. Tang *et al.* (1992) mentioned that iron deficiency severely depresses nodule mass, nodule hemoglobin content and crop yield.

It is known that zinc is active in many enzymatic reactions and a high soil pH means that zinc is less soluble. Crops under these soil conditions may suffer from zinc deficiency. In this respect, El-Fouly (1982), Abd El-Hadi *et al.* (1986) found that highest yield increments were associated with foliar spraying of micronutrient elements especially Zn chelate. They found that faba bean is pulse crop most sensitive to zinc deficiency, especially if soils have a pH higher than 7.0. Concerning Mg, Hafiz and El-Kholy (2001) found that foliar application of Mg on the lupine, significantly increased root length, plant height, number of branches, dry weight, chlorophyll content, number of pods, pod and seed yields. Also, Saad and El-kholy (2001) found that most of the growth parameters and yield components of faba bean significantly increased with the foliar application of magnesium.

As can be observed from the data in Table 1, there is a high value of EC and Na. It is known that under saline conditions, the nutrients uptake decreased and induced nutrient deficiencies. These deficiencies reduce plant growth and crop yield. Reduce deficit by easily readily absorbed forms of humic by plant foliage could led to improving nutrient status and improved yield and yield components. The improvment in nutrient contents by spraying humic acid previously mentioned by some authors such as Wittwer and Bukovac (1969) who found that foliar application improved root growth and led to greater absorbing surface. Also, Guvenc *et al.* (1999) found that nutrient contents of leaves of lettuce treated with foliar HA and Trisert-CB were significantly higher than those of controls.

Table 5: Effect of varieties on nutrient uptake of faba bean seeds (Combined analysis of two seasons)

Nutrient / Variety	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
	kg/feddan					g/feddan			
Giza-461	32.1	0.64	14.5	1.65	1.55	40.4	9.9	38.9	8.1
Giza-3	32.7	0.57	14.8	1.63	1.17	50.6	8.8	36.2	6.8
Giza-429	27.0	0.71	15.4	1.51	1.20	41.7	8.9	38.4	9.0
LSD 5%	1.93	0.08	0.91	0.11	0.04	2.75	0.75	2.09	0.61

*** Feddan = 0.42 ha**

Table 6: Effects of foliar sprays of humic acid on nutrient uptake of faba bean seed (Combined analysi of two seasons)

Nutrient / Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
	Kg/feddan					g/feddan			
Control	23.2	0.48	11.5	1.24	0.95	27.1	7.0	25.8	5.2
5 cm humic acid/l	32.5	0.69	16.3	1.79	1.47	54.6	11.0	41.2	9.7
10 cm humic acid/l	30.6	0.70	16.1	1.60	1.37	48.2	9.9	40.4	7.9
20 cm humic acid/l	36.1	0.68	15.7	1.75	1.42	47.1	8.9	43.9	9.1
LSD 5%	1.45	0.06	0.97	0.22	0.06	3.14	1.22	2.99	0.74

*** Feddan = 0.42 ha**

Table 7: Effect of interaction of treatments and varieties on nutrient uptake of faba bean seeds

Variety	Treatment	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
		Kg/feddan*					g/feddan			
Giza-461	Control	23.3	0.53	10.5	1.43	1.10	24.3	6.8	25.9	4.7
	5 cm humic acid/l	27.9	0.61	12.9	1.42	1.60	41.1	9.8	33.7	8.8
	10 cm humic acid/l	31.3	0.58	14.7	1.40	1.51	41.6	9.4	37.1	9.0
	20 cm humic acid/l	45.8	0.83	20.0	2.34	1.97	54.6	13.7	59.0	10.0
Giza-3	Control	21.9	0.32	11.2	1.02	0.80	35.4	6.6	25.5	4.5
	5 cm humic acid/l	48.7	0.85	20.7	2.38	1.58	72.6	12.4	52.5	10.7
	10 cm humic acid/l	28.5	0.64	15.4	1.79	1.25	47.7	9.3	36.1	4.5
	20 cm humic acid/l	31.7	0. 46	11.9	1.32	1.03	46.8	6.7	30.6	7.6
Giza-429	Control	24.3	0.59	12.8	1.28	0.95	21.7	7.7	25.9	6.4
	5 cm humic acid/l	21.0	0.62	15.2	1.56	1.23	50.1	10.7	37.4	9.7
	10 cm humic acid/l	32.0	0.87	18.3	1.60	1.34	55.3	11.1	48.0	10.2
	20 cm humic acid/l	30.7	0.76	15.1	1.58	1.27	39.8	6.2	42.2	9.6
LSD 5%		3.84	0.11	1.83	0.22	0.08	5.49	1.50	4.17	1.20

*** Feddan = 0.42 ha**

From the above mentioned results, it may be concluded that humic acid as foliar application have positive effect on plant nutrients and can reduce nutrient deficiencies, under saline conditions particularly at a rate of 20 cm/l. Also, cultivars differed in response to foliar application of humic acid, and variety Giza-461 showed the most beneficial response in this respect.

Conclusion

From the present study, it can be concluded that foliar application with humic acid improved nutrient status and balanced nutrient supply, which, promoted yield and yield components of faba bean plants grown under unfavorable soil conditions. Foliar application of humic acid for Giza-461 at concentration of 20 cm/l was the best.

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تأثير الرش الورقي بالهيومك آسد على المحصول وامتصاص العناصر المغذية لبعض أصناف الفول البلدي في الأراضي الجديدة

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أجريت تجربتان حقليتان في أراضى رملية حديثة الاستزراع بقرية الإمام الغزالى التابعة لمديرية جنوب التحرير بمحافظة البحيرة ، خلال موسمين متتاليين ٢٠٠٦/٢٠٠٧ و٢٠٠٧/٢٠٠٨ باستخدام أصناف الفول البلدى جيزة٤٦١، جيزة ٣ ، جيزة ٤٢٩ . لدراسة تأثير الرش بالهيومك اسد ٢,٩% والمحتوى على ن ، فو ، بو (١٠،١٠،١٠ %) والمنتج تجاريا على المحصول ومكوناته وامتصاص العناصر لنباتات الفول البلدي المنزرعة في الأراضي الرملية الحديثة الاستصلاح بتركيزات . ، ٥، ١٠، ٢٠ سم/لتر.

بينت النتائج وجود فروق معنوية بين المعاملات والكنترول لمحصول البذور والمحصول البيولوجى ودليل الحصاد. أظهر التفاعل مابين الرش بالهيومك والأصناف المستخدمة أن الرش الورقى بالهيومك أسد بتركيز ٢٠سم/لتر على الصنف جيزة ٤٦١ عظم عدد ووزن القرون ومحصول البذور والقش والمحصول البيولوجي.

أدى الرش بجميع تركيزات الهيومك إلى تأثير إيجابي على امتصاص العناصر من قبل البذور مقارنة بالكنترول وكان أعلى امتصاص لعنصر النتروجين مع الرش بتركيز ٢٠سم/لتر ، واعلى امتصاص لعنصرى الحديد والمنجنيز مع الرش بتركيز ٥سم/لتر . أعطى التفاعل مابين الرش بالهيومك والأصناف المستخدمة أعلى امتصاص للعناصر مع رش الهيومك بتركيز ٢٠سم/لتر على الصنف جيزة ٤٦١ ومع تركيز ٥سم /لترعلى الصنف جيزة ٣ ومع تركيز ١٠سم/لتر على الصنف جيزة ٤٢٩. أوضحت النتائج أهمية إضافة الهيومك لتحسين امتصاص العناصر ومحصول البذور تحت ظروف التجربة والأصناف تحت الدراسة.

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