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EFFECT OF HUMIC ACID AND COMPOST APPLIED ALONE OR IN COMBINATION WITH SULPHUR ON SOIL FERTILITY AND FABA BEAN PRODUCTIVTIY UNDER SALINE SOIL CONDITIONS

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ABSTRACT

Two field experiments were conducted at El-Qantra Shark, Ismalia Governorate, Egypt in two successive winter seasons of 2011/2012 and 2012/2013. It aimed to study the effect of compost or humic acid at different rates separately applied or combined with sulphur on sme soil properties and its content of available nutrients and faba bean(Vicia faba cv) Varity Nobaria 1 productivity as well as the seeds content of macro- micronutrients , protein and proline under saline soil conditions. The compost application was at the rates 0, 4, 8, 12 Mg fed^{-1} was done 25 day before planting. The application of humic acid was at the rates 0,10, 15 and 20 kg fed^{-1}. The sulphure was applied at rate 400 kg before 25 days from sowing.

Results obtained showed that, the soil pH decreased with increasing the rate of humic acid and compost. The soil salinity EC (dSm^{-1}) was not significantly affected by the different rates of humic acid and compost applied alone or combined with sulphur. The application of humic acid or compost at high rates combined with sulphur gave the highest soil available N, P , K, Fe, Mn and Zn values after faba bean harvesting in both seasons. Also, the faba bean pods yield and seed yields (Mg fed^{-1}) tends to increase due to the application of humic acid (20 kg fed^{-1}) alone or combined with sulphur than the untreated in both seasons. On the other hand, raising the compost levels, applied alone or combined with sulphur, led to increase the seeds yield (Mg fed^{-1}), weight of 100 seeds (g) and No. of pod plant^{-1}, compared to control. The effect of applied different rates from humic acid and compost on N content in seeds was not significant in both seasons, while the increase was significant in P, K, Fe, Mn and Zn content in seeds faba bean in both seasons. The effects of sulphur and organic on protein content in seeds of faba bean plant were significantly in both seasons. The prolien content in faba bean plant was significantly decreased in first season, while it was significantly decreased due to humic and compost application in both seasons. Compost application significantly affected on total chlorophyll content. The sulphur application with humic or compost indicated significant increase in total chlorophyll.

From the previous results, it can be concluded that the use of humic acid at the rate of 15 kg fed^{-1} combined with sulfur or average 8 tons per fed of compost combined with sulfur to give the economical grain yield where there is not significant differences between the rates of 15 kg humic acid and 20 kg per fed, as well as compost 8 tons and 12 tons under saline soil.

Keyword: Humic acid – Compost – Sulphur – Soil salinity and Faba bean.

INTRODUCTION

Soil salinity has become a serious environmental problem which affects the growth and productivity of many crops. High salt content in the soil affects the soil porosity and also decreases the soil water potential that results in a physiological drought. High salt content also affects the physiology of plants, both at the cellular as well as whole plant levels (Murphy and Durako 2003).

Sulphur is one of the major essential plant nutrients, and it contributes to an increase in crop yields by providing direct nutritional value and improving the use efficiency of other essential plant nutrients, particularly nitrogen and phosphorus, (Catherine, 2009). Ayup *et al*., (2007) found that the application of sulphur reduced soil pH slowly from 8.5 to 7.5 in about 20 weeks. Magdi *et al*., (2013) showed that values of soil EC and pH was improved as a result of S treatments. On the other hand S application cause slightly increases in Na content (3.55%) and moderately increases with Cl (34.38%), which led to decrease Na: K ratio by about 39.4%. Regarding to the S effect, application S developed faba bean fresh and dry weight by about 5.2% and 2.3% relative to the control treatment. S addition decreased proline by about 15.9%. Sulphure application increased N, P and K content, in plant by about 118.8%, 132.8% and 62.2% as compared with the control one, respectively. Bob (2011) found that the sulfur application effects on soil pH were gradual, causing only a slight reduction. Soil available P and sulfate (SO_4)-S, increased with increasing S applied. Omran (2012) reported that nitrogen and P concentrations of the faba bean plants were increased by farmyard manure alone. Also, the elemental sulphur is biologically oxidized to H_2SO_4 in soil under aerobic conditions. The oxidation of S to H_2SO_4 is particularly beneficial in alkaline soils to reduce pH, supply SO_4^{-2} to plants, make P and micronutrients more available, and reclaim soils. Orman and Kaplan (2011) reported that 3 weeks after application of 200 ppm elemental sulphur to calcareous sandy loam soil resulted in 0.18 unit decrease in soil pH, according to control soil.

Humic acid (HA) is one of the main organic fertilizers, which is an important component of humic substances. Humic acid is produced by the chemical and biological decomposition of organic material. Humic acid is a vital component of soil organic matter which improves the growth of many plant species. It enhances soil fertility and improves physical and chemical characteristics of soil, like permeability, aeration, aggregation, water holding capacity, ion transport and availability through pH buffering, Tan (2003). Masciandaro *et al*., (2002) indicated that humic substances might counteract abiotic stress conditions, pH and salinity enhancing the uptake of nutrients and reducing the uptake of some toxic elements. Turan *et al*., (2011) indicated that humic acid had positive impacts on dry weight and the N, P, K, Fe, Mn and Zn uptake of maize plants.

The role of compost in salt-affected soils is very vital because the organic source is ultimate opportunity to improve the physical properties of such soils which have been deteriorated to the extent that water and air passage become extremely difficult in such soils. Resultantly, the water stands on the surface of these soils for weeks long. The plants when grown under these conditions often die due to deficiency of root respiration. The compost can be a very good organic amendment in saline agriculture as well as for reclamation of salt-affected soils (Zaka *et al*., 2003 and Sarwar *et al*., 2010). Physical and chemical properties of soil can be improved by using compost, which may ultimately increase crop yields. Physical properties like bulk density, porosity, void ratio, water permeability and hydraulic conductivity were significantly improved when FYM (10 t ha^{-1}) was applied in combination with chemical amendments, resulting in enhanced rice and wheat yields in sodic soil (Hussain *et al*., 2001). Ahmad (2007) found that the organic matter in soil play an important role through building up soil aggregates and enhancing proper soil physical and chemical properties. Enrichment of organic matter in soil decrease soil temperature and mitigates salinity effect and increase moisture conservation stimulates crop growth and quality (Zribi *et al*., 2011).

Faba beans (Vicia faba) is considered the first legume crop in the arable area of Egypt. Total yield is consumed as green and dry seeds in human feed because the plant has high lev els of protein (18 %), carbohydrates (58 %), vitamins and other minerals. In addition to the improvement of soil texture and its fertility, the plant seeds are considered as a valuable source for energy and proteins (National program for pulses crops- Agricultural Research Center, Giza, Egypt, 2002) and Mohsen *et al*., (2013).

The aim of this investigation was to clarify the role of humic acid and compost applied alone or combined with sulphur on the soil fertility and faba bean productivity under saline loamy sand soil conditions.

MATERIAL AND METHODS

Two field experiments were carried out at El-Qantra Shark , Ismailia Governorate, Egypt, during the two successive winter seasons of 2011/2012 and 2012/2013. It aimed to study the effect of sulphur application at the rate of 400 kg mineral sulphur alone or in combination with humic acid at the rate of (0 , 10 ,15 and 20 kg fed^{-1}) and different compost levels (0, 4, 8, and 12 Mg fed^{-1}) , on soil fertility and faba bean (*Vicia faba* L.) productivity under newly reclaimed saline soil conditions. Before and after carrying out the field experiments, sample of soil sites was taken for physical and chemical analysis according to the methods described by Cottenie *et al*., (1982) and Page *et al*., (1982). Some soil physical and chemical analysis before faba bean planting are presented in Table (1).

Table (1) Some physical and chemical properties of soil before faba bean planting.

Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Soil texture	OM (%)	$CaCO_3$ (%)
7.78	75.22	5.60	11.40	Loamy Sand	0.56	4.92

pH (1:2:5)	EC (dS/m)	Cations (meq/l)				Anions (meq/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO^{-}_3	Cl^{-}	SO^{--}_4
8.24	8.22	6.59	12.72	62.03	0.86	6.17	43.80	32.23

Available nutrients in soil					
Macronutrients (mg/kg)			Micronutrients (mg/kg)		
N	P	K	Fe	Mn	Zn
37	4.55	196	2.77	1.24	0.70

The seeds of faba bean (*Vicia faba* L.) cv. (Nobaria 1) were obtained from the Agricultural Research Center, Giza, Egypt. The seeds were sown on 25 November in both the first and second seasons. The experimental pilot unit area (plot) was 5 m of length X 10 m of width. The distance between rows was 50 cm and between plants was 20 cm. Seeds yield at harvest was recorded in 25 April in both seasons. Sulphur was added at the rate of 400 kg fed^{-1} before 25 days from sowing during the soil tillage. Compost was added the rates of 0, 4, 8, 12 Mg fed^{-1} before 25 days from sowing during the soil tillage.

Compost was plowed 25 days before faba bean planting at the rate of 10 ton fed^{-1}.

The preparation of compost was done by using two ton of straw crop residuals (straw rice, maize stover and faba bean straw), air – dried made into 5 – 10 layers, each about 50cm thick. Application of 300 kg/ pile of farmyard manure were added to enhance microorganism activity, and it was then supplied with a sufficient quantity of water. Every 21 days the heap of crop residuals was turned over until it became well decomposed as described by Nasef *et al*., (2009). The compost analysis was done according to the standard methods as described by Brunner and Wasmer (1978).

Chemical composition of the used compost is shown in Table (2).

Table (2) analysis of compost used in study

EC	pH	C	O.M	N	P	K	Fe	Mn	Zn	C/N
dSm^{-1}	(%)						($mg.kg^{-1}$)			ratio
3.46	7.44	25.5	44.00	1.94	0.66	1.70	130.00	98.00	62.00	13.1:1

Humic acid was applied at the rates of 0, 10, 15, 20 kg fed^{-1} before 3 days from seeds planting. Calcium super phosphate was added at the rate of 30 kg P_2O_5 during the soil tillage. Potassium sulphat (48 % K_2O) fertilizer was added at the rate of 24 kg K_2O fed^{-1} after 21 and 45 days from planting. Nitrogen (Urea 46 %) was added at the rate 30 kg N fed^{-1} after added in three equal doses 21, 40 and 55 days from planting. The experimental design was split split plot treatments being replicated 3.

At harvesting the plants of each replicate were taken separately and divided into straw and seeds. Then some growth parameters i.e . weight seeds yield, pods yield , 100 seed and No. of pod plant^{-1} were carried on separated seeds .Samples of seeds were ground and 0.5 g powder of each was digested by concentrated digestion mixture of H_2SO^4// $HClO_4$ acids according to Cottenie *et al.,* (1982). Nitrogen was determined by micro Keldahl, according to Jackson (1967). Phosphorus was determined Spectrophotometrcally using ammonium molybdate/ stannus chloride method according to Chapman and Pratt (1961). Potassium was determined by a flame photometer, according to Page *et al.,* (1982). Fe, Mn, and Zn were determined by using Atomic Absorption (model GBC 932). Crude protein content was estimated by conversion of nitrogen percentage to protein (Kang *et al*., 2012). Protein % = N% x Conversion factor (6.25).

All data were subjected to statistical analysis according to Snedecor and Cochran (1990). Total chlorophyll (chlorophyll a +chlorophyll b) was determined using spectrophotometric method described by Metzner *et al,.* (1965). Proline was estimated according to Bates *et al.* (1973).

RESULTS AND DISCUSSION

Soil pH

Soil pH is an important chemical property because it affects the availability of nutrients to plants and the activity of soil microorganisms.

The effect of humic acid and compost of applied alone or combined with sulphur on soil pH are presented in Table (3). The data showed that the soil pH decreased with increasing the levels humic acid and compost. The lowest value of soil pH was 8.08 for soil treated with compost by the rate of 12 Mg fed^{-1} in the second season. Humic acid reduced soil pH from 8.22 to 8.13 in the first season and from followed by compost where it decreased from 8.21 to 8.10 and from 8.18 to 8.08 in the first and second season , respectively . These results are in agreement with Yaduvanshi (2001) and Sarwar *et al* (2008) they observed a decrease in soil pH after the use of organic materials. The production of organic acids (amino acid, glycine, cystein and humic acid) during mineralization (amminization and ammonification) of organic materials by heterotrophs and nitrification of NH4 produced by autotrophs would have caused this decrease in soil pH.

The application of humic acid and compost in combination with sulphur gave more decrease in soil pH value was (8.00) for soil treated with compost at the rate of 12 Mg fed^{-1} combined with sulphur ,while the lowest soil pH (8.04) was obtained from the soil treated with humic acid by rate 20 kg fed^{-1} combined with sulphur. The soils of all experimental plot were characterized by slight to moderate alkaline conditions, where the pH value is always around 8.28 – 7.94. These findings are in agreement with those reported by Wahdan *et al.* (1999). These results are in agreement with Sule (2012) who indicated that elemental sulphur is biologically oxidized to H_2SO_4 in soil under aerobic conditions.

Table (3) Effect of humic acid and compost added alone or in combination with sulphur on Soil pH, EC, N, P and K in soil after faba bean harvesting.

Sulphur	Treatments	Rates	pH (1:2.5)		EC (dSm^{-1})		N ($mgkg^{-1}$)		P ($mgkg^{-1}$)		K ($mgkg^{-1}$)	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0	Humic acid (kg fed^{-1})	0	8.22	8.19	7.75	6.53	40.84	41.00	4.85	4.92	201	202
		10	8.17	8.15	6.82	5.52	44.28	44.78	4.93	4.98	204	206
		15	8.15	8.14	6.30	5.21	46.00	47.22	4.96	5.02	206	208
		20	8.13	8.12	5.39	4.88	47.59	49.12	4.98	5.08	207	210
	Mean		----	---	6.57	5.54	44.68	45.53	4.93	5.00	205	207
	Compost (Mg fed^{-1})	0	8.21	8.18	7.45	6.39	40.95	41.33	4.90	4.94	203	205
		4	8.15	8.14	5.90	5.39	45.77	46.44	5.03	5.07	208	209
		8	8.12	8.12	5.49	5.12	47.82	49.66	5.08	5.12	213	216
		12	8.10	8.08	4.85	4.37	49.72	50.33	5.12	5.15	215	219
	Mean		---	--	5.92	5.32	46.07	46.94	5.03	5.07	210	212
Sulphur (400 kg fed^{-1})	Humic acid (kg fed^{-1})	0	8.18	8.16	6.94	6.50	41.30	42.90	4.92	4.96	203	206
		10	8.10	8.08	5.88	5.28	45.25	46.19	5.07	5.09	214	216
		15	8.08	8.07	5.24	4.65	48.66	50.33	5.09	5.11	217	218
		20	8.05	8.04	4.80	4.33	51.12	52.46	5.12	5.13	219	223
	Mean		---	--	5.72	5.19	46.58	47.97	5.05	5.07	213	216
	Compost (Mg fed^{-1})	0	8.16	8.13	6.90	6.89	41.88	42.95	4.94	4.98	204	208
		4	8.08	8.07	5.96	5.55	47.71	49.61	5.12	5.14	217	219
		8	8.05	8.03	4.77	4.53	49.27	51.27	5.14	5.17	224	226
		12	8.01	8.00	4.30	4.23	52.00	53.83	5.17	5.19	228	231
	Mean		---	----	5.48	5.30	47.72	49.42	5.09	5.12	218	221
LSD. 5% Rates			---	--	ns	Ns	ns	1.22	ns	ns	1.26	3.13
LSD. 5% sulphur			---	---	0.42	0.58	1.96	2.15	ns	ns	1.40	1.62
LSD. 5% organic			---	---	0.97	0.77	2.95	2.26	ns	ns	1.52	1.98

The oxidation of S to H_2SO_4 is particularly beneficial in alkaline soils to reduce pH. Claudio *et al*. (2007) found that the decrease in the soil pH value depends on the soil and the compost characteristics as well as on the dose and time of application. Increasing the period between compost application and the plantation to 30 days resulted in low soil pH values.

Soil salinity (EC dSm^{-1})

Soil salinity after faba bean harvest as affected by different rates of organic matter sources alone or in combination with sulphur is given in Table (3). The data reveal that the values of soil salinity EC (dSm^{-1}) was insignificantly affected by increasing the rates of humic and compost alone or combination with sulphur. Concerning the effect of humic acid or compost applied alone or combined with sulphur on soil salinity were significantly slightly affected. The corresponding relative decrease of mean values soil salinity as affected by humic acid in combination with sulphur compared with humic acid applied alone was 12.94 % in first season and 6.32 % in second season.

On the other hand the relative decrease of mean values soil salinity as affected by compost in combination with sulphur compared with application of compost alone was 7.43 % in first season and 0.37 % in second season. Application of humic acid and compost alone or combined with sulphur led to a decreased soil salinity because humic acid and compost could improve the soil physical properties (increasing soil porosity). The decomposition of compost and humic acid releases acids forming compounds and active microorganisms, which react with the soluble salts already present in soil either to convert them into soluble salts or at least increase their solubility .These findings are in agreement with those reported by Tandon (2000) who found that physical properties (hydraulic conductivity, bulk density and total porosity) of salt affected soil greatly improved when compost is applied. Mohamed (2012) found that the electric conductivity (EC) of the soil treated with humic acid (HA) application were lower in HA application compared to the non-treatment of HA. However, the effect of application of dose (1.0 g A kg^{-1} soil) was not significant compared with control. The EC values of soil decreased significantly with doses (2.0 and 3.0 g HAkg^{-1}soil) treatments. This could be due to the role of humic acid in improving soil aggregation and water movement leaching the excessive soluble salts.

The content of available macronutrients in soil under study..

The data representing available N, P and K as affected by humic acid and compost rates applied alone or in combination with sulphur after faba bean harvest are shown in Table (3) statically analysis revealed that humic acid and compost rats application significantly increased the soil available K in both season. Effect of all treatments under study had not significantly increased the soil P availability in both seasons. On the other hand, the applied humic acid and compost rates were not significantly increased the soil N availability in first season, while the effect of humic acid, compost rates and sulphur were significantly increased the soil N in second season. However , the application of humic acid or compost at the high rates in combination with sulphur gave the highest soil available N, P and K values after faba bean harvesting in both seasons. The corresponding relative increase of mean values soil N, P and K availability as affected by humic acid combined with sulphur compared with humic acid application alone were 4.25 % in first season and 5.36 % in second season for N; 2.43 % in first season and 1.40 % in second season for P and 3.90 % in first season and 4.35 % in second season for K, respectively. On the other hand, the relative increases of mean values soil N, P and K availability as affected by compost combination with sulphur compared with compost applied alone were 12.87 % in first season and 14.68 % in second season for N; 2.78 % in first season and 2.31 % in second season for P and 8.57 % in first season and 8.90 % in second season for K, respectively. These results are in agreement with Dhanushkodi and Kannathasan (2012) and Eletr *et al.*, (2013) they found that the addition of organic soil conditioners well decomposed and humified organic matter adds mineralized nitrogen and humic substances, this reduces the loss of N from leaching and volatilization. Also, soil conditioners induced increase in the availability of K because soil conditioners itself adds an appreciable quantity of K to the soil and also due to rapid decomposition and mineralization which release higher amount of NH_4^+ ion leading to increase the availability of K in soil. Sule (2012) indicated that Supply SO_4^{-2} to plants, make P and more available, and reclaim soils.

The content of available micronutrients in soil under study.

Soil pH an important chemical property affects nutrient availability and microbial activity. Micronutrients such as Fe, Mn and Zn are readily available at lower soil pH. Soil organic matter or humic substances influence micronutrients availability through chelating, which can either increase or decrease the available micronutrients (Mackowiak *et al*., 2001).

It is evident from data presented in Table (4) that pronounced increases in soil available micronutrients (Fe, Mn and Zn) were achieved as a result of high rates of humic acid and compost application alone or in combination with sulphur. This is more related to the residual organic compounds that directly after different biochemical and chemical changes, which led to releas more available microelements. From the aforementioned results, it could be concluded that Fe, Mn and Zn tend to increase in studied soil with increasing the rates of humic acid and compost alone or in combination with sulphur. Concerning the effect of humic acid and compost rates alone or in combination with sulphure, the available Mn in soil was significantly increased in both seasons. On the other hand, the increase available Fe was significant in second season and Zn in both seasons. Also, the application of humic acid and compost alone was significantly increased Zn in second season, while the humic acid and compost in combination with sulphur was insignificantly increased.

Table (4). Effect of humic acid and compost added alone or in combination with sulphur on Fe , Mn and Zn contents in soil after faba bean harvesting.

Sulphur	Treatments	Rates	Fe ($mgkg^{-1}$)		Mn ($mgkg^{-1}$)		Zn ($mgkg^{-1}$)	
			1st	2nd	1st	2nd	1st	2nd
0	Humic acid (kg fed^{-1})	0	2.81	2.83	1.33	1.32	0.79	0.82
		10	2.95	2.97	1.56	1.58	0.84	0.85
		15	2.98	3.00	1.58	1.60	0.86	0.86
		20	2.98	3.01	1.62	1.64	0.87	0.88
	Mean		2.93	2.95	1.52	1.54	0.84	0.85
	Compost (Mg fed^{-1})	0	2.83	2.84	1.35	1.37	0.82	0.83
		4	2.97	3.02	1.59	1.61	0.96	0.98
		8	3.02	3.04	1.64	1.65	0.98	1.00
		12	3.03	3.04	1.66	1.68	0.98	1.01
	Mean		2.98	2.99	1.56	1.58	0.94	0.96
Sulphur (400 kg fed^{-1})	Humic acid (kg fed^{-1})	0	2.84	2.86	1.36	1.38	0.84	0.87
		10	3.04	3.04	1.65	1.67	0.98	0.99
		15	3.06	3.07	1.69	1.72	1.02	1.02
		20	3.06	3.08	1.72	1.73	1.03	1.04
	Mean		3.00	3.01	1.61	1.63	0.97	0.98
	Compost (Mg fed^{-1})	0	2.84	2.85	1.39	1.42	0.85	0.87
		4	3.09	3.12	1.72	1.76	0.98	1.00
		8	3.12	3.16	1.77	1.80	1.04	1.05
		12	3.14	3.18	1.79	1.83	1.07	1.08
	Mean		3.05	3.08	1.67	1.70	0.99	1.00
LSD. 5% Rates			0.030	ns	0.100	0.022	ns	ns
LSD. 5% sulphur			ns	ns	0.010	0.013	ns	0.093
LSD. 5% organic			ns	ns	0.007	0.020	ns	ns

Fe in soil for the tow seasons. The corresponding relative increases of mean values for Fe, Mn and Zn in soil as affected by humic acid combined with sulphur compared with humic acid alone were 2.40 % in first season and 2.03 % in second season for Fe; 5.92 % in first season and 5.84 % in second season for Mn and 15.47 % in first season and 15.30 % in second season for Zn, respectively. However, the relative increases of mean values for Fe, Mn and Zn in soil affected by compost combined with sulphur compared with compost alone were 2.35 % in first season and 3.01 % in second season for Fe; 7.01 % in first season and 7.60 % in second season for Mn and 5.32 % in first season and 4.20 % in second season for Zn, respectively. These results are in agreement with Mackowiak *et al*.,(2001) who indicated that application of humic acid positively influenced micronutrients availability, in soil.

Shaban *et al*., (2012) indicated that the availability of micronutrients in soil depends on the change of soil pH, resulted from the tested treatments soil amendments (gypsum, sulphur and compost).

Effect of humic acid and compost added alone or in combination with sulphur on faba bean productivity under saline soil conditions.

Data presented in Table (5) show that faba bean pods yield and seed yields (Mg fed^{-1}) tends to increase in soil treated with humic acid at the rates of 20 kg fed^{-1} and applied alone or combined with sulphur applied than the untreated in both seasons. All studied treatments led to increases in all parameters. Moreover, the humic acid application alone or in combination with sulphur led to increase seed yield; weight of pods yield ; 100 seeds (g) and No. of pod plant with increasing humic acid levels compared with the untreated one. The relative increase of mean values seed yield; pods yield;100 seeds (g) and No. of pod plant as affected by humic acid combined with sulphur compared with humic alone were 9.82 % in first season and 9.73 % in second season for seeds yield (Mg fed^{-1}) ; 10.55% in first season and 9.13 % in second season for yield of pods (Mg fed^{-1}) ; 6.86 % in first season and 12.87 % in second season for weight of 100 seeds (g) and 12.87% in first season and 12.92 % in second season for No. of pod plant^{-1}, respectively. These results are in agreement with Türkmen *et al.,* (2004) they reported that 1kg HA kg^{-1} soil of humic acid application positively affected plant growth under saline soil conditions.

Table (5).Effect of humic acid and compost added alone or in combination with sulphur on yield and yield compound.

Sulphur	Treatments	Rates	Weight of seeds Yield (Mgfed^{-1})		Weight Yield of pod (Mg fed^{-1})		Weight of 100 seeds (g)		No. of pod/plant	
			1st	2nd	1st	2nd	1st	2nd	1st	2nd
0	Humic acid (kg fed^{-1})	0	1.045	1.065	2.172	2.179	65.89	65.90	9.12	9.25
		10	1.091	1.098	2.183	2.195	72.90	73.00	10.66	10.76
		15	1.182	1.186	2.197	2.196	75.13	75.33	11.54	11.68
		20	1.184	1.186	2.198	2.199	77.84	77.90	11.89	11.96
	Mean		1.12	1.13	2.18	2.19	72.94	73.03	10.80	10.91
	Compost (Mg fed^{-1})	0	1.065	1.066	2.173	2.179	66.43	66.53	9.45	9.55
		4	1.181	1.182	2.389	2.396	75.60	75.90	11.34	11.45
		8	1.186	1.187	2.499	2.522	79.72	80.47	12.22	12.45
		12	1.187	1.189	2.530	2.536	80.31	80.82	12.23	12.55
	Mean		1.15	1.16	2.40	2.41	75.52	75.93	11.31	11.50
Sulphur (400 kg fed^{-1})	Humic acid (kg fed^{-1})	0	1.067	1.075	2.177	2.178	66.82	67.00	10.66	10.77
		10	1.286	1.287	2.395	2.403	79.45	79.67	12.43	12.67
		15	1.289	1.291	2.527	2.430	82.33	82.48	12.78	12.85
		20	1.291	1.294	2.536	2.543	83.18	83.23	12.88	12.97
	Mean		1.23	1.24	2.41	2.39	77.95	78.10	12.19	12.32
	Compost (Mg fed^{-1})	0	1.067	1.077	1.178	1.180	67.45	67.97	10.82	10.94
		4	1.391	1.397	2.508	2.513	80.34	80.55	13.27	13.34
		8	1.394	1.396	2.543	2.550	82.60	82.75	13.44	13.52
		12	1.395	1.396	2.567	2.573	83.77	83.57	13.73	13.88
	Mean		1.31	1.32	2.20	2.20	78.54	78.71	12.82	12.92
LSD. 5% Rates			0.001	0.058	ns	ns	0.75	3.25	0.550	0.49
LSD. 5% sulphur			9.55	0.029	ns	ns	2.67	2.49	0.430	0.39
LSD. 5% organic			5.52	0.001	ns	0.191	1.570	2.050	0.190	0.43

On the other hand the compost levels applied alone or combined with sulphur led to increase the seeds yield (Mg fed^{-1}), weight of 100 seeds (g) and No. of pod plant^{-1} with increasing compost rates compared with control. The highest values of seeds yield was 1.396 Mg fed^{-1} obtained under the level of 8 and 12 Mg fed^{-1}) from compost combined with sulphur application. The relative increases of mean values of seed yield; 100 seeds (g) and No. of pod plant as affected by compost application combined with sulphur compared with compost applied alone were 13.91 % in first season and 13.79 % in second seasons for seeds yields; 4.00 % in first season and 3.70 % in second season for weight of 100 seeds (g) and 13.35 % in first season and 12.34 % in second season for No. of pod plant^{-1}, respectively. Statically analysis of data showed that the effect of humic acid and compost rates application was significant increased seeds yield; weight of 100 seeds (g) and No. of pod plant^{-1}. The application of humic acid and compost alone or combined with sulphur generally had positive effects and increased significantly, seeds yield; weight of 100 seeds (g) and No. of pod plant^{-1}. These results are in agreement with Abdallah *et al*., (2013) they found that the highest faba bean grain yield was obtained by increasing sulphur application up to 500 kg S fed^{-1}. El-Shouny and Behiry (2011) suggested that application of compost and sulphur alone or in combination enhancements the seed yield of faba bean. Zayed *et al*., (2005) stated that the application of FYM at the level of 5.0 ton/fed produced the highest mean values of yield and yield biomasses as well as grain yield and straw yield wheat plant.

Macronutrients concentration in faba bean seeds.

Effect of used different rates humic acid and compost with or without sulphur on N, P and K concentration in faba bean plant seeds, presented in Table (6). It can be noticed that the soil treated with sulphur caused a positive effect on N, P and K concentration in faba bean seeds as compared to soil without sulphur in both seasons. On the other hand, the effect of applied different rates from humic acid and compost on N content in seeds was not significant in both seasons, while it significantly increases

Table (6).Effect of humic acid and compost applied alone or in combination with sulphur on N, P and K concentration in faba bean seeds.

Sulphur	Treatments	Rates	N (%)		P (%)		K (%)	
			1st	2nd	1st	2nd	1st	2nd
0	Humic acid (kg fed^{-1})	0	2.55	2.61	0.49	0.51	1.18	1.22
		10	2.74	2.77	0.52	0.55	1.23	1.28
		15	3.19	3.20	0.55	0.57	1.34	1.35
		20	3.24	3.25	0.57	0.60	1.37	1.40
	Mean		2.93	2.96	0.53	0.56	1.28	1.31
	Compost (Mg fed^{-1})	0	2.80	2.82	0.48	0.53	2.15	2.18
		4	2.87	2.88	0.58	0.62	2.19	2.24
		8	3.22	3.25	0.59	0.64	2.22	2.29
		12	3.27	3.30	0.62	0.66	2.26	2.31
	Mean		3.04	3.06	0.57	0.61	2.21	2.26
Sulphur (400 kg fed^{-1})	Humic acid (kg fed^{-1})	0	2.84	2.86	0.53	0.55	1.93	1.95
		10	2.88	2.93	0.62	0.64	1.98	2.02
		15	3.28	3.32	0.66	0.67	2.05	2.07
		20	3.33	3.36	0.68	0.69	2.09	2.12
	Mean		3.08	3.12	0.62	0.64	2.01	2.04
	Compost (Mg fed^{-1})	0	2.86	2.88	0.54	0.55	2.19	2.20
		4	3.12	3.16	0.66	0.68	2.23	2.25
		8	3.17	3.19	0.69	0.70	2.29	2.30
		12	3.19	3.23	0.71	0.73	2.33	2.35
	Mean		3.09	3.12	0.65	0.67	2.26	2.28
LSD. 5% Rates			ns	ns	0.020	0.026	0.234	0.005
LSD. 5% sulphur			ns	ns	0.013	0.015	ns	0.016
LSD. 5% organic			0.013	0.366	0.014	0.028	ns	0.006

P and K percentage in faba bean seeds in both seasons. The N, P and K concentration in seeds were significantly affected by humic acid and compost application in both seasons. The sulphur application with or without humic acid and compost were significantly affect P content in seeds but insignificant on N in both seasons. The K concentration in seeds was significantly increased in second season. Concerning, the corresponding relative increases of mean values of N, P and K concentration in faba bean seeds plant as affected by humic acid application combined with sulphur as compared without sulphur were 5.12 % in first season and 5.40 % in second season for N; 16.98 % in first season and 14.28 % in second season for P and 5.70 % in first seasons and 5.60 % in second season for K, respectively.

Also, the relative increases of mean values N, P and K concentration in faba bean seeds as affected by compost with sulphur compared without sulphur were 1.64 % in first season and 1.96 % in second season for N; 14.03 % in first season and 9.83 % in second season for P and 2.26 % in first season and 1.00 % in second season for K, respectively. These results are in agreement with Hussein and Hassan (2011) who indicated that application of humic acids increased the uptake of P and K in faba bean plant. El-Shouny and Behiry (2011) found that application of compost and sulphur alone or in combination enhancements the uptake of N, P and K in wheat plant.

Micronutrients concentration in of seeds faba bean plant.

Data presented in Table (7) show that the additions of humic acid and compost level separat or in combinations with sulphur significantly increased Fe contents in faba bean seeds in both seasons, while the increase in Mn was significant in first season only. Also, Zn was insignificantly increased in both seasons. The addition of humic acid and compost rates significantly increased, Fe, Mn and Zn concentration in faba bean seeds plant in the two seasons.

Table (7). Effect of humic acid and compost added alone or in combination with sulphur on Fe; Mn and Zn concentrations in faba bean seeds.

Sulphur	Treatments	Rates	Fe ($mgkg^{-1}$)		Mn ($mgkg^{-1}$)		Zn ($mgkg^{-1}$)	
			1st	2nd	1st	2nd	1st	2nd
0	Humic acid (kg fed^{-1})	0	85.63	85.77	49.53	50.27	18.22	19.00
		10	97.34	99.10	55.19	59.33	19.30	20.63
		15	99.71	99.86	61.52	61.66	22.45	23.18
		20	105.22	109.00	63.40	64.09	23.67	24.55
	Mean		96.98	98.43	57.41	58.84	20.91	21.84
	Compost (Mg fed^{-1})	0	85.83	86.21	50.46	50.55	22.58	22.63
		4	107.49	110.63	56.88	57.29	23.10	23.28
		8	112.52	113.70	63.98	64.15	23.64	23.67
		12	118.00	121.40	66.10	66.43	24.83	24.88
	Mean		105.96	107.99	59.36	59.61	23.54	23.62
Sulphur (400 kg fed^{-1})	Humic acid (kg fed^{-1})	0	86.14	86.23	51.29	51.35	23.47	23.55
		10	108.88	112.40	60.78	60.99	24.85	25.08
		15	116.17	118.26	64.33.	65.94	25.33	25.47
		20	123.52	125.49	66.28	67.27	26.49	26.65
	Mean		108.68	110.60	59.45	61.39	25.04	25.19
	Compost (Mg fed^{-1})	0	88.67	88.75	51.86	52.00	24.00	24.10
		4	120.48	120.66	62.05	62.18	25.69	25.77
		8	129.36	130.00	65.39	66.02	26.42	27.03
		12	133.52	134.12	68.21	70.18	27.35	27.42
	Mean		118.01	118.38	61.88	62.60	25.87	26.08
	LSD. 5% Rates		4.27	4.45	1.65	1.10	1.47	1.57
	LSD. 5% sulphur		1.99	2.10	2.25	3.22	ns	0.68
	LSD. 5% organic		1.21	0.68	1.77	1.76	1.69	1.42

As well as the application of humic acid and compost significantly increased the Fe, Mn and Zn. The effect of sulphur application for all treatments was significant in both seasons. The highest mean values of Fe, Mn and Zn content in seeds were 118.38; 62.60 and 26.08 mg kg^{-1}, respectively, for soil treated with compost combined with sulphur compared with other treatments. Also, The relative increases of mean values Fe, Mn and Zn contents in seeds as affected by humic acid combined with sulphur compared with without were 12.06 % in first season and 12.36 % in second season for Fe; 3.55 % in first season and 4.33 % in second season for Mn and 19.75 % in first season and 15.33% in second season for Zn, respectively. On the other hand, the relative increases of mean values Fe, Mn and Zn contents in seeds as affected by compost combined with sulphur compared with without were 11.37 % in first season and 9.62 % for Fe ; 4.24 % in first season 5.01 % in second season for Mn and 9.89 % in first season and 10.47 % in second season for Zn , respectively. These results are in agreement with Mohamed (2012) who suggested that the addition of humic doses generally increased significantly, micro nutrients uptake. Sule (2012) indicated that supply SO_4^{-2} to plants, make P and micronutrients more available, and reclaim soils. Hussein and Hassan (2011) indicated that humic acids increased the uptake of P, K, Mg, Na, Cu and Zn.

Effect of humic aicd and compost applied alone or in combination with sulphur on protein, porlien and chlorophyll content in faba bean plant.

The results in Table (8) indicat that humic acid and compost at different rates applied alone or combined with sulphur was positive effect on protein (%) content in faba plant seeds. The humic acid at the rate of 20 kg fed^{-1} combined with sulphur led to increase protein percentage in seeds of the two seasons compared with other treatments. Comparing the EC (dSm^{-1}) values in the soils (Table 3) and protein content of seeds presented in Table (8) my be noted that clear decrease of faba bean seeds content of protein (%) with the increase soil salinity, these results reflected the inhibitor effect of soil salinity on plant growth and nitrogen (%) content. These results are in agreement with those found with Hammad *et al.*, (2010) , they found that the protein content in peanut seeds decreased with increasing soil salinity. The protein content of seeds in second season was higher than found the first season. In both seasons, results in Table (8) indicate that humic acid and compost rates application was significant increase of protein (%) content in seeds. on the other hand , the effect of sulphur and organic on protein content in seeds faba bean plant were significantly in both seasons. These results are in agreement with Siam *et al.* (2013) indicated that protein (%) content in grain wheat increased with high rates of mineral N combined with compost. Abd El-Gawas (2013) declared that humic acid at the rate of 8 kg fed-1 increased protein percentage of seeds in the two seasons.

The presented data in Table (8)show that the effect of humic acid and compost rates application on the prolien content in faba bean plant was negatively significant in first season, while the affect was negative and significant by humic and compost application in both seasons. The prolien content in faba bean plant was negative and significant as affected by sulphur application. The proline content values were increase with increasing soil salinity in both seasons (Table 1and 8). The highest values 4.98 and 4.53 (µ mole g^{-1} f.wt) of proline content in faba bean plant were found at soil untreated with humic or compost, these results reflected that high soil salinity. These results may be due to the accumulating of osmolytes that do not perturb enzyme functions so as maintain continuous water absorption at low soil water potaintion, (Hammad *et al*., 2010).

Table (8) Effect of humic acid and compost applied alone or in combination with sulphur on protein , prolien and total chlorophyll content in faba bean.

Sulphur	Treatments	Rates	Protein (%)		Prolien (µ mole g^{-1} F.wt)		Total chlorophyll (mg g^{-1} f.w)	
			1st	2nd	1st	2nd	1st	2nd
0	Humic acid (kg fed^{-1})	0	15.94	16.31	4.98	4.92	0.56	0.58
		10	17.13	17.31	4.11	4.08	0.54	0.55
		15	19.94	20.00	3.92	3.71	0.83	0.86
		20	20.25	20.31	3.76	3.62	1.05	1.08
	Mean		18.31	18.48	4.19	4.08	0.75	0.77
	Compost (Mg fed^{-1})	0	17.50	17.63	4.53	4.48	0.77	0.80
		4	17.94	18.00	4.05	4.00	0.84	0.86
		8	20.13	20.31	3.69	3.47	0.88	0.89
		12	20.44	20.63	3.54	3.31	1.09	1.12
	Mean		19.00	19.14	3.95	3.82	0.90	0.92
(Sulphur) (400 kg fed^{-1})	Humic acid	0	17.75	17.88	4.12	4.06	0.92	0.95
		10	18.00	18.31	3.85	3.89	1.09	1.13
		15	20.50	20.75	3.72	3.38	1.20	1.22
		20	20.81	21.00	3.37	3.21	1.33	1.34
	Mean		19.27	19.48	3.77	3.64	1.14	1.16
	Compost (Mg fed^{-1})	0	17.88	18.00	3.99	3.85	1.20	1.22
		4	19.50	19.75	3.53	3.42	1.36	1.38
		8	19.81	19.94	3.25	3.18	1.52	1.53
		12	19.94	20.19	3.11	3.04	1.57	1.60
	Mean		19.28	19.47	3.47	3.37	1.41	1.43
LSD. 5% Rates			0.57	0.50	0.46	ns	0.061	0.041
LSD. 5% sulphur			0.33	0.30	0.25	0.38	0.032	0.025
LSD. 5% organic			0.29	0.57	0.43	0.25	0.045	0.041

Results in same Table, show that the humic acid and compost rates significantly increased the total chlorophyll in the two seasons. However the highest value of total chlorophyll was obtained from compost combined with sulphur application at 8 and 12 Mg fed^{-1} compared with other treatments. The effect of humic acid and compost application on total chlorophyll content was significant increase. The sulphur application with humic or compost was significant increase of total chlorophyll.

Conclusions

Applications of humic acid and compost at high rates to soil alone or combined with sulphur improved the soil properties of saline soil (EC and pH). Also the humic acid and compost combined with sulphur increased the available nutrients in soil. As well as, the improved of macro and micronutrients content in faba bean seeds plants, which reflected on the increased of seeds yield and its components. On the other hand the protein and chlorophyll increased with increasing rates of humic and compost combined with sulphur application the studied treatments faba bean plants tolerance for soil salinity .

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تاثير اضافة الهيوميك والكمبوست المتحد مع الكبريت والغير متحد على خصوبة التربة وانتاجية الفول تحت ظروف الاراضى الملحية

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اجريت تجربتـان حقليتـان بمنطقـة القنطـرة شـرق بمحافظـة الأسـماعلية فـى الموسـم الستوى ٢٠١٢/٢٠١١ و ٢٠١٢/ ٢٠١٣ علـى التـوالى لدراسـة تـاثير اضـافة معـدلات مـن الهيوميـك اسـيد والكمبوسـت متحـدين او غيـر متحـدين مـع الكبريـت علـى خصـوبة التربـة وانتاجيـة الفـول البلـدى صـنف نوباريـة ١ تحـت ظـروف الأراضــى الملحيـة. كـان معـدلات الكمبوست هى٠ و٤ و ٨ و ١٢ طن للفدان وتم اضـافتهم قبل الزراعـة ب ٢٥ يوم وكذلك كانت معدلات الهيوميك اسيد ٠ و ١٠ و ١٥ و ٢٠ كجم للفدان وتـم اضـافتها قبل الزراعة ب ٣ ايام وكان معدل اضافة الكبريت حوالى ٤٠٠ كجم للفدان وتم اضافتهم قبل الزراعة ب ٢٥ يوم .

وكانت النتائج كالتالى :

وجد ان تـاثير الهيوميك اسيد والكمبوست منفردا او متحد مـع الكبريت ادى الـى نقص حموضة التربة . وكان تاثير المعدلات الكمبوست و الهيوميك اسيد غير معنوى علـى ملوحة التربة . لوحظ ان اضافة الكمبوست والهيوميك اسيد منفردين او متحدين مـع الكبريت ادت الـى زيـادة فـى تيسر العناصـر فـى التربـة نتـروجين – فوسفور- بوتاسيوم – حديد منجنيز- والزنك.

زاد محصول القرون والحبوب للفدان بزيادة معدلات الهيويمك اسيد والكمبوست المتحدين بالكبريت (٢٠ كجم للهيوميك للفدان) .

كان تاثير المعدلات من الهيوميك اسيد والكمبوست تاثير غير معنوى لمحتوى الحبوب من النتروجين ولكن كان لهم تاثير معنوى على محتوى الحبوب من الفوسفور والبوتاسيوم والحديد والمنجنيز والزنك فى الموسمين.

كان لتاثير الهيوميك اسيد والكمبوست تاثير معنوى على مختوى البذور من البروتين . وكان تاثير كل المعاملات على البرولين معنوى فى الموسم الاول وغير معنوى فى الموسم الثانى. وزيادة الكلوروفيل زيادة معنوية فى الموسمين .

من النتائج السابقة يمكن ان نوصى بان نستخدم معدل ١٥ كجم من الهيوميك للفدان متحد مع الكبريت والمعدل ٨ طن للفدان متحد مع الكبريت لاعطاء محصول حبوب افضل حيث لا يوجد فرق معنوى بين المعدلات ١٥ كجم هيوميك اسيد و ٢٠كجم للفدان وكذلك الكمبوست ٨ طن و ١٢ طن للفدان فى الاراضى الملحية .

قام بتحكيم البحث

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