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EFFECT OF POTASSIUM FERTILIZATION AND ORGANIC MATERIALS ON SOME CHARACTERISTIC GROWTH AND NUTRIENTS UPTAKE BY FABA BEAN (*VICIA FABA L.*) PLANT

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Abstract

A field experiment carried out at the experimental area of the El- kantera shark, north sinai, Egypt, during season of 2017/2018 to study the effect of four potassium fertilization rates (0, 15, 30 and 45 kg k_2O /fed as potassium sulphate (50% K_2O) and four treatments of organic materials (without organic, humic, fulvic, compost). humic and fulvic added rate of 30 kg/fed; meanwhile compost added rate of 10 ton/fed, on straw, seeds, pods, either nutrients content and uptake by faba bean in sandy soil. The obtained results showed that application of the potassium fertilization and sources of organic materials added to soil alone or in combination with each other led to significantly increase of dry of straw, seeds, pods (g/plant), plant height, (cm). In addition, the nitrogen, phosphorus, potassium and some micronutrients uptake of seeds in faba bean significantly increase with increasing K fertilization a combined with source of organic materials, the highest values was recorded with the treatments of 45 kg K_2O/fed with humic acid. This may be attributed to the influence of potassium addition on K availability in soil; Moreover the effect of potassium in plant metabolism which increases nutrient absorption. Generally, from these results it can be concluded that the application of potassium fertilization rates and organic materials sources improved all growth characteristics and nutrients uptake of faba bean plant.

***Key words*:** Potassium fertilizer, humic substance, nutrients uptake, plant.

Introduction

Potassium plays a vital role as a macronutrient in plant growth and sustainable crop production (Baligar *et al.,* 2001). It maintains turgor pressure of cell which is necessary for cell expansion. It helps in osmo-regulation of plant cell, assists in opening and closing of stomata. It plays a key role in activation of more than 60 enzymes (Bukhsh *et al.,* 2011). Goals aimed toward increasing crop productivity and improved quality dictate either increased potassium supply or more efficient use of potassium. Developing plants that more efficiently use potassium might be a worthwhile goal for geneticists (Pettigrew, 2008). Also, potassium element is very important in overall metabolism of plant enzymes activity, it was found to serve a vital role in photosynthesis by direct increasing in growth and total yield. Also, potassium has a beneficial effect on water consumption (Mansour, 2006); Mansour and Aljughaiman (2012, 2015); Mansour et al., (2014, 2016). Taha *et al*., (2016) who found that, the EC and pH of soil was decreased with increasing rates of potassium sources. The available nutrients in soil (N, P, K and Fe) increased significantly with increasing rates of potassium fertilizers. Natarajan and Renukadevi (2003) studied the effect of potassium fertilization rate on yield of sorghum, they found that potassium fertilization at all rates increased yield. Ali and Mowafy (2003) found that adding potassium fertilizer caused significant increase in seed yield and all their attributes.

Ferrara and Brunetti (2010) who reported that, the application of humic acid significantly increased width and weight of berries collected at harvest with respect to the control treatment; as well as increase nutrient uptake by the grapevines berry quality of table grape. While, Magdi *et al*., (2011) reported that, bio-fertigation of microbial inoculums and humic substances could be used as a complementary for mineral fertilizers to improve yield and quality of cowpea under sandy soil conditions. Also, Arancon *et al.,* (2006) showed that the humic acid from vermin composts can enhance nutrient availability and improve chemical, biological, and physical soil properties. Similarly, Meganid *et al.*, (2015) who found that, the humic acid supply significantly increased the relative growth rates of shoot and root under saline conditions and humic is considered as a promising soil amendment to overcome adverse effects of salinity stress.

The direct and indirect beneficial effects of humic acid on plant growth and development are their effect on cell membranes which lead to the enhanced transport of minerals, improved protein synthesis, plant hormone-like activity, promoted photosynthesis, modified enzyme activities, solubility of micro-elements and macro-elements, reduction of active levels of toxic minerals and increased microbial populations, (Hamideh *et al.*, 2013). Benefits ascribed to the use of humic acid, particularly in low organic matter, alkaline soil, include increased nutrient uptake, tolerance to drought and temperature extremes, activity of beneficial soil microorganisms and availability of soil nutrients (Russo and Berlyn, 1990). Humic acid are the main fraction of humic substances and the most active components of soil and compost organic matter. Humic acid can enhance nutrient availability and improve chemical, biological, and physical soil properties (Selim *et al.*, 2009). Meanwhile, Nardi *et al.* (2002). Stated that, the effects of humic substances on plants, results show that the, humic acid can enhance nutrient availability and improve chemical, biological, and physical soil properties. Selimand and Mosa, (2012) stated that, effect of humic substances on yield and quality of broccoli and nutrient retention in a sandy soil. Results indicated that, humic acid can enhance nutrient availability to plant and improve chemical, biological, and physical soil properties.

The main goals of this study the effect of organic materials with potassium rate under water drip irrigation system on yield and nutrients uptake by faba bean plant.

Materials and Methods

A field experiment carried out in the experiment area of the El-kantara shark, north sinai, Egypt, to study the effect of potassium fertilization and source of organic materials under drip irrigation system on straw weight (g), seeds weight (g), pods weight (g), height (cm) of plant either nutrients content and uptake by faba bean plant *(Vicia faba* L.*)* grown in sandy soil. The experiment using a randomized complete Plock design with three replications, The experimental unit area was 7.5 m^2 (3 x 2.5 m), 12 rows in each plot and 20 cm apart; during season of 2017/2018 to study the effect of four potassium fertilization rates (0, 15, 30 and 45 kg K_2O /fed as potassium sulphate (50% K_2O) were added on the two doses after 30 and 60 days of planting, and four treatments of organic materials (without organic, humic, fulvic, compost); humic and fulvic added rate of 30 kg/fed, were added on the three doses after 20, 40 and 60 days of planting; meanwhile compost added rate of 10 ton/fed, was added before planting; other fertilized according to the general recommendations by Ministry of Agriculture. Plant samples, straw and seeds, were taken at harvesting time (120 days after planting), dried at 70 ºC. Then, dry weight was calculated in g.plant^{-1}, pods and seeds. Determine N, P, K and some micronutrients concentrations in plant; the following data were recorded; N, P, K and some micronutrients in seeds of plant as well as content of nutrient in seeds.

Table 1 : Some physical and chemical properties of investigated soil.

Particle size distribution			**Texture**	**pH (1:2.5)**	**EC(ds/m)**	**$CaCO_3$ %**	**Soluble ions in 1:5 soil water extract (meq /100g)**							
Sand (%)	**Silt (%)**	**Clay (%)**	**Loamy sand**	**7.70**	**0.61**	**0.69**	**Ca^{++}**	**Mg^{++}**	**Na^+**	**K^+**	**CO_3^{--}**	**HCO_3^-**	**SO_4^{--}**	**Cl^-**
82.20	10.50	7.30					0.81	0.40	0.90	0.82	0.00	0.92	0.96	1.05

Table 2a: Some chemical properties of the used compost.

pH	**EC dS/m**	**OC %**	**MO%**	**C/N ratio**	**Total macronutrients %**					**Total micronutrients ppm**			
					N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
6.77	2.98	19.22	34.00	12:1	1.60	1.10	1.60	0.95	0.52	120	85	70	12

Table 2b: Some chemical properties of the used water.

Soluble ions meq/L								**EC dS/m**	**pH**
Ca^{++}	Mg^{++}	Na^+	K^+	CO^{--}_3	HCO^{--}_3	Cl^-	SO^{--}_4		
2.75	2.06	4.30	2.35	0.00	5.02	4.12	2.32	1.35	7.8

The soil sample was routinely analyzed according to (Klute, 1986) and (Page *et al.*, 1982) the results are presented in Table 1. Plant analysis; total nitrogen was determined using Kjeldahl method, phosphorus was determined colorimetrically, potassium by flame photometer Page *et al*. (1982). The micronutrients (Fe; Mn and Zn) were determined by Inductively Coupled Plasma Spectrometer (ICP) Plasma 400. Statistical analysis: finally all obtained data were subjected to analysis of variance and treatment means were compared by L.S.D. test at the 5% level of probability in the experimented season according to Gomez and Gomez (1984).

Results and Discussion

Dry Matter Yields (Straw and Seeds)

Data presented in Table 3 show that the dry matter yield of straw and seeds were significantly affected by application of potassium rates and source of organic materials at all treatments; and the highest values of dry matter yield were recorded with 45kg fed^{-1} potassium sulphate with humic acids compared with the other treatments and the control. The highest values were 19.27 and 12.82 g/plant in straw and seeds respectively. The effect of potassium sulphate in the soil may be attributed to the role of sulphate in potassium sulphate played by this acidic component for minimizing the values of soil pH and, subsequently facilitate the absorption of nutrients by the roots of faba beans plants. The positive effects of humic substances on yields have demonstrated the importance of optimum mineral supply, independent of nutrition. These results are in a partial agreement with those obtained by Nardi *et al.* (2002). Stated that, the effects of humic substances on plants, results indicated that the, humic acid can enhance nutrient availability and improve chemical, biological, and physical soil properties. In addition, Natarajan and Renukadevi (2003) studied the effect of potassium fertilization rate on yield of sorghum, they found that potassium fertilization at all rates increased yield. Also, Ali and Mowafy (2003) found that adding potassium fertilizer caused significant increase in seed yield and all their attributes.

Table 3: Effect of potassium fertilization and some organic materials on some characteristics of faba bean plant.

K-rate kg/fed (A)	Source of Organic materials (B)	straw weight (g/plant)	weigh pods (g/plant)	Height (cm/plant)	Weight seeds (g/plant)	Weight 100 seeds (g)
Control		12.28	10.30	80.29	8.17	50.42
0.0	humic	16.13	12.86	85.72	10.73	52.32
	fulvic	14.99	12.10	82.40	9.97	50.91
	compost	15.38	12.36	83.40	10.23	51.62
Mean		14.70	11.91	82.95	9.78	51.32
15.0	-	15.74	12.60	84.41	10.47	55.54
	humic	16.76	13.28	95.62	11.15	57.65
	fulvic	16.37	13.02	92.29	10.89	52.62
	compost	17.09	13.50	94.29	11.37	57.21
Mean		16.49	13.10	91.65	10.97	55.76
30.0	-	16.49	13.10	88.38	10.97	64.21
	humic	19.05	14.80	110.59	12.67	66.41
	fulvic	16.94	13.40	105.29	11.27	64.21
	compost	17.32	13.65	108.02	11.52	65.48
Mean		17.45	13.74	103.07	11.61	65.08
45.0	-	16.91	13.38	89.38	11.25	65.58
	humic	19.27	14.95	115.92	12.82	70.56
	fulvic	17.27	13.62	112.71	11.49	65.23
	compost	18.91	14.71	114.29	12.58	68.56
Mean		18.09	14.17	108.08	12.04	67.48
LSD at 5%						
A		0.220	0.104	0.012	0.036	0.0012
B		0.220	0.104	0.012	0.036	0.0012
A×B		0.440	0.208	0.020	0.072	0.0024

Dry weight of pods, seeds, height plant and dry weight of 100 seeds: With regard to the effect of using potassium fertilization rates and source of organic materials on growth parameter data in Table

3 reveal that the mean values of pods, seeds (g/ plant), height plant (cm) and dry weight of 100 seeds of faba bean plant were significantly increase with increasing K-rate with all source of organic materials. The highest values were observed with adding recorded with 45kg fed^{-1} potassium sulphate with humic acids compared with the other treatments and the control. These results could be attributed to the role of potassium element in metabolism and many processes needed to sustain and promote plant vegetative growth and development. Moreover, K plays a major role in many physiological and biochemical processes such as cell division and elongation and metabolism of carbohydrates and protein. These results are in harmony with those obtained by (McDonnell *et al*., 2001) humic substances are an important soil component because they constitute a stable fraction of carbon, improve water holding capacity and pH buffering; which increases nutrient absorption leading to the increase in dry weight. In addition Mansour (2006) who indicated that, potassium element is very important in overall metabolism of plant enzymes activity, it was found to serve a vital role in photosynthesis by direct increasing in growth and total yield.

Table 4: Effect of potassium fertilization and some organic materials on some Macronutrients content and uptake in seeds by faba bean plant bean plant.

K-rate kg/fed (A)	Source of Organic materials (B)	Macronutrients content (%)			Macronutrients uptake (mg/plant)			Protein (%)
		N	P	K	N	P	K	
Control		1.88	0.18	1.32	153.23	14.67	107.74	11.73
0.0	humic	2.16	0.26	1.43	231.31	27.86	153.41	13.48
	fulvic	2.08	0.23	1.40	206.95	22.89	139.53	12.98
	compost	2.12	0.25	1.41	216.43	25.54	144.20	13.23
Mean		2.06	0.23	1.39	201.98	22.74	136.22	14.54
15.0	-	2.33	0.28	1.38	243.49	29.28	144.46	15.35
	humic	2.46	0.29	1.61	273.81	32.29	179.50	14.42
	fulvic	2.31	0.28	1.52	251.09	30.45	165.51	14.48
	compost	2.32	0.29	1.55	263.30	32.93	176.23	14.85
Mean		2.36	0.29	1.52	257.92	31.24	166.43	16.10
30.0	-	2.38	0.28	1.40	260.61	30.68	153.57	15.73
	humic	2.58	0.30	1.62	326.35	37.97	205.29	15.73
	fulvic	2.52	0.28	1.54	283.52	31.52	173.55	15.04
	compost	2.52	0.31	1.57	289.81	35.67	180.86	16.29
Mean		2.50	0.29	1.53	290.07	33.96	178.32	15.79
45.0	-	2.41	0.29	1.53	270.64	32.58	172.12	16.35
	humic	2.61	0.31	1.70	334.06	39.70	217.98	11.73
	fulvic	2.53	0.29	1.61	290.20	33.28	184.99	13.48
	compost	2.62	0.30	1.62	329.06	37.70	203.83	12.98
Mean		2.54	0.30	1.62	305.99	35.82	194.73	13.23
LSD at 5%								
A		0.0012	0.002	0.021	2.60	0.059	0.64	0.0036
B		0.0012	0.002	0.021	2.60	0.059	0.64	0.0036
A×B		0.0024	0.005	0.042	5.20	0.118	1.29	0.0072

Macronutrients content and uptake by faba bean plant

Data presented in Table 4 show that, the effect of potassium fertilization on N, P, K and protein content (%) in seeds of faba bean plant; the increasing of K application led to increasing N, P, K and protein content (%) in straw and seeds of faba bean plant; as well as the NPK uptake (mg/plant) in straw and seeds by faba bean plant increased with increasing K application; N, P and K uptake (mg/plant) significantly increase with increasing K fertilization a combined with source of organic materials, the highest values was recorded with the treatments of 45 kg K_2O/fed with humic acid**.** This may be attributed to the influence of potassium addition on K availability in soil; Moreover the effect of potassium in plant metabolism which increases nutrient absorption. These results are in harmony with those obtained by Selim *et al.* (2009) who found that, that, humic acid can enhance nutrient availability and improve chemical, biological, and physical soil properties. Meanwhile, Hussien (2007) reported that Potassium application (up to 30 kg/fed) significantly increased N content (%) of canola plants.

Micronutrients content and uptake by faba bean plant

Regarding the effect of using potassium fertilization rates and and source of organic materials on some micronutrients µg/plant (Fe, Mn and Zn) data in Table 3 show that, the uptake of this nutrients in seeds by faba bean plant increased with increasing K application. Fe, Mn and Zn uptake (µg/plant) significantly increase with increasing K fertilization a combined with source of organic materials, the highest values was recorded with the treatments of 45 kg K_2O/fed with humic acid. This may be attributed to the influence of potassium addition on K availability in soil; Moreover the effect of potassium in plant metabolism which increases nutrient absorption. These results are in harmony with those obtained by Russo and d Berlyn (1990) Application of humic substances have been shown to increase membrane permeability, photosynthesis, some nutrients uptake, nitrogen use efficiency and root elongation.

Table 5: Effect of potassium fertilization and some organic materials on some Micronutrients content and uptake in seeds by faba bean plant.

K-rate kg/fed (A)	Source of Organic materials (B)	Micronutrients content (ppm)			Micronutrients uptake (µg/plant)		
		Fe	Mn	Zn	Fe	Mn	Zn
control		6.50	3.17	4.20	52.74	25.57	33.98
0.0	humic	26.54	5.97	6.50	284.34	63.72	69.40
	fulvic	20.44	5.63	8.90	203.37	55.79	88.39
	compost	23.23	5.72	8.91	237.22	58.17	90.80
Mean		19.18	5.12	7.13	194.42	50.81	70.64
15.0	-	22.11	6.63	6.71	231.07	69.07	69.91
	humic	37.54	9.11	8.54	418.10	101.22	94.87
	fulvic	32.42	8.51	9.11	352.60	92.33	98.86
	compost	35.52	9.10	10.12	403.40	103.12	114.71
Mean		31.90	8.34	8.62	351.29	91.44	94.59
30.0	-	26.33	6.90	7.80	288.40	75.35	85.22
	humic	38.33	9.20	12.40	485.16	116.21	156.75
	fulvic	35.23	8.71	9.54	396.58	97.82	107.17
	compost	37.69	9.32	10.15	433.72	107.02	116.58
Mean		34.40	8.53	9.97	400.97	99.10	116.43
45.0	-	35.32	7.12	8.20	396.88	79.76	91.90
	humic	39.3	9.40	15.30	503.35	120.16	195.78
	fulvic	36.63	9.21	12.32	420.41	105.47	141.20
	compost	39.58	10.11	13.17	497.43	126.83	165.32
Mean		37.71	8.96	12.25	454.52	108.06	148.55
LSD at 5%							
A		0.23	0.20	0.22	2.22	1.28	1.26
B		0.23	0.21	0.22	2.22	1.28	1.26
A×B		0.46	0.42	0.43	4.45	2.56	2.51

Conclusion

Results obtained in the present work confirmed that organic materials specific of humic acid was able to produce some positive effects in faba bean (*Vicia faba L.*). In particular, significant improving characteristic of plant growth, nutrients content and uptake by plant, the highest values have been observed due to humic acid application with rate potassium fertilizers.

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