RESPONSE OF FABA BEAN PLANTS TO ORGANIC AMENDMENTS ON CALCAREOUS SOIL

BY

Mohamed M.I. Afifi, Yasser S. El-Akshar, Yahia I.M. Zaen and

Rehab A.M. Abd Elrahman

FROM

Soils, Water and Environment Research Institute, Agriculture Research Center, Egypt.
Field Crops Research Institute, Agriculture Research Center, Egypt.

ABSTRACT

Faba bean (*Vicia faba* L.) is one of the principal winter legume crops in Egypt as a source of protein for feed and food. Growth and yield of faba bean are greatly influenced by both physical and chemical properties of calcareous soil. Two field experiments were carried out at Nubaria region during the two successive seasons of 2015/2016 and 2016/2017 to study the effect of different organic amendments on growth, nodulation, yield and nutrients uptake of two varieties of Faba bean namely Nubaria 1 and Nubaria 2, and four organic amendments namely; compost, humic acid, fulvic acid and compost tea were applied. Results reveled, humic acid combined with 50% mineral NPK fertilizer achieved the highest significant increase in plant height and number of branches for both varieties during the two seasons. Fulvic acid application accompanied by 50% NPK significantly increased yield reaching 9.38 and 11.0 ard./fed for Nubaria 1 and Nubaria 2, respectively. The yield of cultivar Nubaria 1 was greater than cultivar Nubaria 2 during both seasons. Humic and compost applications resulted in substantial increasing both number and fresh weight of nodules. The total counts of rhizosphere bacteria, fungi and actinomycetes as well as the dehydrogenases activity were increased due to compost and compost tea application. Meanwhile, humic acid amendment enhanced nitrogenase activity as measured by the acetylene reduction assay (ARA) during season 2015/2016. On the other hand, amendment with fulvic aid improved nitrogenase activity during the second growing season of 2016/2017. The highest NPK uptake was recorded in shoot and grains of plants grown in soil amended with fulvic acid. Fulvic acid application as well resulted in a significant increase in protein content in grains of both varieties during two seasons.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important pulse crops in Egypt; it plays an important role in world agriculture due to the high protein content, its ability to fix atmospheric nitrogen and its capacity to grow well on marginal lands (Alghamdi, 2007; Farag and Afiah, 2012). Addition of organic fertilizers efficiently ensures high production and continuous cropping by improving soil properties and increasing root development and soil microorganisms activity (Abou EL-Magd *et al*., 2006; Ayoola and Maknide, 2009). Therefore, addition of organic matter i.e.

organic manure, humic acid and compost extract is recommended as an alternative to chemical fertilizers (Oad *et al*., 2004).

Fulvic and humic acids as organic matter are among the means available to achieve sustainability in agricultural production. They play a vital role because of their beneficial effects on soil physical, chemical and biological characteristics (Afifi, 2010). Humic substances namely humic acid, fulvic acid and humin act as soil conditioners and as bio-catalysts, improve soil properties and increase root development. Humic substances are recently introduced; there are divergent findings about humic substance effects on plant (Sant'anna *et al*., 2009). Its effects may be attributed to many factors, including the natural source and concentration of humic substances, soil pH, and plant species, the humic compounds may be absorbed by the roots and transported to shoots, enhancing the growth of the whole plant (Lulakis and Petsas, 1995). Humic substances can be added to the soil for improving crop yield. A benefit of humic acid due to its ability to complex metal ions and form aqueous complexes with micronutrients and also may form an enzymatically active complex, which can be carried on reactions that are usually assigned to the metabolic activity of living microorganisms (Tejada *et al*., 2006). So, the use of these organic substances in such soil showed a good means in that concern (Habashy *et al*., 2008). The major functional groups of humic acid include carboxyl, phenolic hydroxyl, alcoholic hydroxyl, ketone and quinoid as represented by Russo and Berlyn (1990).

Compost tea can be prepared in a short period of time and can be applied directly onto plant surface. However, effects of compost tea are short lived and frequent and thus repeated applications are required to replenish plant or soil surface with nutrient and/or beneficial microbes, (Scheuerell and Mahaffee 2002, Brinton *et al.* 2004, Ingham 2005).

This study was planned to examine the impact of various organic amendments i.e. compost (Olive mill solid residues compost), humic acid (soil application), fulvic acid and compost tea (foliar application) individually or in combination on growth and yield of faba bean cultivars grown on calcareous soil.

MATERIALS AND METHODS

This study was conducted on a newly-reclaimed calcareous soil grown with two Broad bean cultivars (*Vicia faba*, L Nubaria 1, and Nubaria 2) at Nubaria Experimental Station, Alexandria Govern., Agriculture Research center, Egypt during the two successive winter seasons of 2015/2016 and 2016/2017 .

Interaction effects of some organic fertilizers (compost, humic, fulvic acids and compost tea) on growth and yield of faba bean cultivars were studied. The physicochemical properties of the experimental soil were estimated according to Black *et al*. (1982). The soil texture was sandy loamy having the following characteristics: coarse sand 9.74 % , fine sand 59.12 %, silt 15.7 %, clay 15.44 %, pH 7.43, EC 2.1 dS/m, organic matter 0.26 %, total nitrogen 0.09 %, total phosphorus 0.04 %, total potassium 0.35 % and $CaCO_3$ 21.4 % anions and cations (meq/L): SO_4^{-2} 15.3, CO^-_3 traces, HCO^- 2.40, Cl^- 2.40, Ca^{+2} 8 , Mg^{+2} 1.98, Na^+ 9.58 and K^+ 0.56.

Materials

Organic amendments

1. Compost:

A mixture of olive mill from where obtained solid residues with various agricultural wastes composted for 12 weeks. it was used as a compost material in this work (Mahmoud *et al*., 2012). It has a bulk density of 591 kg/m^3, organic matter 62.1% ,Ash 37.9%, total nitrogen 1.7%, C/N ratio 21.3:1, total phosphorus 0.28%, total potassium1.61%, ammonical nitrogen 30 mg/L, nitrate nitrogen 575 mg/L , pH 8.17 , E.C 5.56 dS m^{-1} compost was added at a rate of 20 tone / Feddan.

1.1 Preparation of compost tea:

Preparation of compost tea was performed by mixing mature compost with tap water in an open container at a ratio of 1:10. It was steeped at ambient temperatures for a week and stirring process for mixture is continuous. After that compost tea was mixed with additives 0.5% (V/V) molasses which for increasing microbial population densities during production compost tea prepared according to the method described by Scheuerell and Mahaffee (2002) and Ingham (2005).

The chemical characteristics of the compost tea were as follows: total nitrogen 0.03%, total phosphorus 0.16%, total potassium 0.23% ammonical nitrogen 38 mg/L, nitrate nitrogen 46 mg/L, pH 7.01, E.C 19.95 dS m^{-1} (APHA, 1989). Compost tea was applied as foliar spray at a rate of 75 L/feddan divided on three equal doses after 30, 45 and 75 days.

1.2. Extraction and purification of humic and fulvic acids:

Extraction of humic (HA) and fulvic (FA) acids from compost were performed according to Sanchez *et al.,* (2002). Purification of HA and FA was accomplished as described by Kononova (1966). Total phosphorus was determined as reluctant (Murphy and Riley, 1962). Total potassium was determined using flame photometry as described by Chapman and Pratt (1961). Both humic and fulvic acids were added at irrigation intervals at a rate of 75% from 200 ppm as recommended by Stevenson (1994). Elemental analysis (C, H, N, S and O) of the purified HA and FA (Table 1) was performed by gas microanalysis (vario elementoric, H, N, S, Germany 2004) as described by Goh and Stevenson (1971). Total acidity of HA and FA acids were determined as mentioned by Dragunova (1958). Carboxyl groups were determined according to Schintzer and Gupta (1965). Phenolic groups were determined as described by Kononova (1966).

Table (1): Characteristic of humic and fulvic acids extracted from compost

Treatment	C (%)	N (%)	H (%)	S (%)	O (%)	P (ppm)	K (ppm)	Total acidity (mmol/100g)	COOH groups (mmol/100g)	Phenolic groups (mmol/100g)
HA	57.1	5.6	5.1	2.1	30.1	0.001	0.017	275	210	310
FA	48.6	2.8	4.3	2.3	42.0	0.016	0.240	600	300	650

The experimental treatments were arranged in split block design with three replicates as the following:

T1. Compost (soil application) + 50 % Nitrogen phosphorus and potassium.N,P and K .

T2. Humic acid (soil application) + 50% NPK .

T3. Fulvic acid (foliar application) + 50% NPK .

T4. Compost tea (foliar application) + 50 % NPK.

T5. Mix (Compost+ Compost tea+ Humic acid+ Fulvic acid).

T6. Control as recommended dose of NPK, as following, Nitrogen (15 kg nitrogen / Fed. divided into three doses after 30, 45 and 75 days of sowing), Phosphorus (200 kg / Fed.) and potassium (50 kg / Fed.). Both phosphorus and potassium were add once during soil preparation before sowing. all treatments except the control one as a half recommended dose, whereas the fifth treatment didn't receive any mineral fertilizer.

Each plot area of 10.5 m^2 contained 6 liners five were cultivated and the sixth one was free to avoid overlapping the distance between each line 30 cm. all plots were planted by hand with one seed per hull.

Measurements:

A- Enzymes, Plant roots were sampled after 45 and 75 days from sowing for determination of the numbers and fresh weight of nodules, nitrogenase activity (µmole C_2H_4/gm for nodules) while nitrogenase activity in rizospher (µmole C_2H_4/gm soil) was estimated according to the methods of Somasegaran and Hoben (1994). Dehydrogenase enzyme activities were determined according Page *et al.*, (1982).

B- Total count of bacteria (cfu g^{-1} soil rhizosphere) (Allen, 1959), fungi (cfu g^{-1} soil rhizosphere) (Martin, 1950) and actinomycetes (cfu g^{-1} soil rhizosphere) (Williams and Davis, 1965), were determined after the end of the experiment.

C- Plants were sampled at harvest to determine total nitrogen, phosphorus and potassium contents in shoots and seeds (Jakson, 1973), plant height (cm), number of branches /plant, number of pods /plant , number of seeds / plant , seed weight /plant (g), and seed yield ardab / Feddan (ardab =155Kg of faba bean yield) .

D- Soil samples were taken to measure EC, pH, organic matter percentages, total nitrogen, phosphorus and potassium according to Black *et al.* (1982).

F- Statistical analysis: The experimental design was split plot arrangement in randomized complete-block design with three replicates. Genotypes were arranged in the main plot while treatments were distributed in the sub-plots; two genotypes

(Nubaria 1 and Nubaria 2) were randomly allocated in the main plots. The sub-plots were designated to six treatments. Statistical analysis: Data were subjected to the proper statistical Analysis of Variance (ANOVA) of split block design as mentioned by Steel and Torrie (1982). Treatment means were compared using the Least Significant Difference (LSD) test at 0.05 as outlined by Waller and Duncan (1969).

RESULTS AND DISCUSSIONS

A key feature of this work was to maximize the benefits from composting agricultural wastes and produce several compost extracts (humic, fulvic acids and compost tea) in order to be used for improving production of calcareous soil cultivated with faba bean plants.

1-Growth parameters and yield

Data presented in Table (2) clear that all plants received the organic amendments were taller than those supplied with the full NPK-dose application in both seasons. Nubaria 1 plants measured up to 95.45 and 98. 48 cm/plant during two seasons. Humic acid application achieved the highest values of plant height during the 2015and 2016 measuring 87.88 and 89.83 cm in height, respectively. Meanwhile, treatment which contents mix of organic fertilizers only obtained 78.63 and 83.47cm during 2015 and 2016 respectively.

Humic acid application significantly increased the mean number of branches in both plant genotypes and seasons. Due to humic acid application, a maximum mean of 7.0 branches/plant was enumerated in 2016 compared to a maximum of 5.98 branches/plant in 2015. Nubaria 1 plants attained more branches than Nubaria 2. The positive effect of humic acid might be due to its growth promoting effect on roots which enhances nutrient uptake and improved plant growth vigor. This was in harmony with the results reported by Afifi *et al* (2014) who found that application of humic acid and inoculation with *Azospirillum brasilense*, *Bacillus megaterium* and *Bacillus circulans* increased plant height, plant dry weight and number of branches in comparison with application of full-NPK dose.

The present data refer to increased numbers of pods and seeds/plant as a result of foliar application of fulvic acid. Plants sprayed with fulvic acid had maxima numbers of 23.24 and 23.61 pods/plant, 71.34 and 72.90 seeds/plant as well as maxima seeds weights of 52.20, 52.62 g seeds / plant during 2015 and 2016, respectively. A superior increase in seed yield/fed was scored by plants sprayed with fulvic acid. The yield of these plants reached up to 9.38 and 11.0 ard/fed compared with amounts of 4.12 and 8.62 ard./ fed for full NPK in both two varieties during the two seasons, respectively.

Data show that plants of the variety Nubaria 1 gave higher pods number/plant as well as seeds numbers and weights compared with Nubaria 2. In addition; it achieved significantly higher seed productivity than Nubaria 2 (6.4 and 10.28 seed yield ard/fed, during the two successive seasons, respectively). This might be ascribed to the fact that fulvic acid is especially active in dissolving mineral nutrients when they are in solution with water. Metallic minerals simply dissolve into the fulvic acid structure and become bio-chemically reactive and mobile. It is worth mention that, plants treated with a mixture of the organic amendments only achieved significantly higher yield/ fed (4.64 and 9.22 ard/ fed) compared with those received the full NPK fertilizer in both seasons. However, the mechanism of humic substances for promoting plant growth is not completely known. Increasing cell membrane permeability, oxygen uptake, respiration, photosynthesis, phosphate uptake and root cell elongation of plant growth factors have been proposed by many authors to explain the positive effect of humic substances Kim Tan (2014).

Table (2): Response of two faba bean varieties to compost , humic substances and compost tea and their interactions on plant height, yield and yield components during two successive winter season2015/2016 and 2016/2017.

Var. / Tr.	Plant height (cm)						No. of branches/plant						No. of pods/plant					
	2015			2016			2015			2016			2015			2016		
	Nub. 1	Nub. 2	Mean	Nub. 1	Nub. 2	Mean	Nub. 1	Nub. 2	Mean	Nub. 1	Nub. 2	Mean	Nub. 1	Nub. 2	Mean	Nub. 1	Nub. 2	Mean
T1	93.10	65.67	**79.38**	95.23	66.33	**80.78**	6.78	2.67	**4.73**	7.25	3.89	**5.57**	21.00	19.14	**20.07**	21.89	20.33	**21.11**
T2	100.0	75..7	**87.88**	102.3	77.33	**89.83**	7.45	4.33	**5.89**	8.33	5.67	**7.0**	22.33	20.89	**21.61**	22.90	21.33	**22.12**
T3	98.00	69.33	**83.67**	100.8	73.33	**87.05**	6.78	3.00	**4.89**	7.64	3.89	**5.77**	22.80	22.67	**23.24**	24.22	23.00	**23.61**
T4	99.87	74.00	**86.93**	101.4	76.00	**88.72**	6.89	4.00	**5.45**	7.67	5.45	**6.56**	23.65	21.95	**22.80**	23.00	22.16	**22.58**
T5	92.23	65.03	**78.63**	101.3	65.80	**83.47**	6.67	2.67	**4.67**	7.00	3.56	**5.28**	21.67	18.78	**20.22**	22.00	19.00	**20.50**
T6	89.40	64.70	**77.05**	90.0	65.00	**77.50**	5.44	2.33	**3.88**	6.33	3.00	**4.66**	20.40	18.00	**19.20**	20.78	18.33	**19.56**
Mean	**95.45**	**69.07**	**82.26**	**98.48**	**70.63**	**84.56**	**6.67**	**3.17**	**4.92**	**7.37**	**4.24**	**5.81**	**22.14**	**20.24**	**21.19**	**22.46**	**20.69**	**21.58**
$LSD_{0.05:}$	**V:**	**3.94**		**7.03**			**0.30**			**0.80**			**0.28**			**0.94**		
	T:	**1.58**		**3.28**			**0.21**			**0.78**			**0.56**			**1.07**		
	VT:	**NS**		**NS**			**0.003**			**NS**			**NS**			**NS**		
	No. of seeds/plant						Seed weight (g/plant)						Seed yield (ard. /fed)					
T1	72.89	64.25	**68.57**	73.57	65.20	**69.38**	53.00	43.00	**48.00**	53.33	43.24	**48.29**	6.44	7.11	**6.78**	9.05	9.70	**9.38**
T2	73.99	65.67	**69.83**	74.60	67.43	**71.01**	53.54	44.80	**49.17**	53.80	45.03	**49.41**	7.44	8.11	**7.78**	9.99	10.25	**10.1**
T3	75.01	67.67	**71.34**	76.00	69.80	**72.90**	57.06	47.33	**52.20**	57.45	47.80	**52.62**	9.31	9.44	**9.38**	10.25	11.70	**11**
T4	74.99	66.69	**70.84**	75.23	68.77	**72.00**	55.00	47.25	**51.13**	55.33	47.77	**51.55**	5.19	6.23	**5.71**	10.13	11.30	**10.7**
T5	69.11	64.54	**66.83**	71.67	66.47	**69.07**	52.53	40.45	**49.49**	52.82	40.70	**46.76**	4.17	5.11	**4.64**	8.68	9.75	**9.22**
T6	69.02	63.20	**66.11**	71.00	64.80	**67.90**	52.20	40.40	**46.30**	52.52	40.60	**46.56**	4.10	4.14	**4.12**	8.24	9.00	**8.62**
Mean	**72.50**	**65.34**	**68.92**	**73.68**	**67.08**	**70.38**	**53.89**	**43.46**	**48.88**	**54.21**	**44.19**	**49.20**	**6.4**	**6.12**	**6.69**	**10.28**	**9.39**	**9.84**
$LSD_{0.05:}$	**V:**	**0.47**		**1.66**			**0.60**			**0.19**			**1.30**			**1.82**		
	T:	**0.25**		**0.81**			**1.31**			**0.28**			**1.27**			**1.52**		
	VT:	**0.35**		**NS**			**NS**			**0.39**			**1.80**			**NS**		

T: treatment V: Varity VT: interaction between treatment and variety

A similar report by Said *et al*.(2014) decided that yield as average number and weight of fruits/plant (cucumber plant) were significantly increased using different concentrations of fulvic acid from 50ppm to 150ppm. Fulvic acid in combination with trace elements and other plant nutrients, as foliar sprays improved growth of plant foliage, roots and fruits. By increasing plant growth processes within the leaves an increase in carbohydrates content of the leaves and stems occurs. The findings of Neveen and Amany *(*2008) recommended the use of mineral and biofertilizers with two verities of faba bean (Sakha-1 and Giza40). Sakha-1 significantly increased in the number of pods and seeds/plant, weight of pods and seeds/plant, seed and straw yield/fed, as well as 100-seed g weight.

2- Numbers and fresh weigh of nodules and nitrogenase in nodules.

The full dose of chemical NPK fertilizer had a low effect on nodule formation by the two examined plant genotypes. In contrast, all the applied organic treatments had a consistent favorable effect on nodule formation by the examined plant varieties when compared with the chemical NPK fertilizer application. Humic acid application was the superior in this respect resulting in the formation of the highest nodule number by both varieties grown in both seasons. For instance, Nubaria 1 plants treated with humic acid formed as high as 210 and 223 nodules/plant in the 1^{st} and 2^{nd} seasons, respectively (Table, 3).

In the soil amended with compost or humic acid, nodule fresh weights were almost 5 times higher than nodules formed by plants supplemented with the full dose of chemical fertilizer. Nodules formed by the variety Nubaria 2 had higher fresh weight than those formed by Nubaria 1 plants being 2961 and 3578 mg/plant with compost treatment during the two seasons, respectively.

Fulvic acid treatment was the superior amendment provoking the highest nitrogenase activity. Nubaria 1 achieved higher nitrogenase activity than Nubaria 2, 0.725 and 1.070 µmole C_2H_4 / g dry nod. Without mineral fertilizer application, the mixed organic fertilizers supported higher nodule formation more than full NPK (control) treatment as shown in Table (3). These results agree with those of Ahmed and El-Abagy (2007) who attributed the differences among faba bean cultivars in growth characters to the differences in number of nodules formed on the root of the tested cultivars, consequently, the growth of each cultivar may be depended mainly on nitrogen fixation, also to the differences in partition and migration of photosynthates between cultivars and the endogenous.

3- Biological parameters in faba bean rhizosphere

The population density of soil microorganisms and the soil enzymatic activities were monitored in the rhizosphere of the examined faba bean varieties in the two successive seasons.

Table (3): Effect of compost, humic substances and compost tea on number, fresh weight and nitrogenase activity in nodules of two faba bean varieties after 45 and 75 days from culture during two seasons 2015/2016 and 2016/2017.

Variety / Treatment		Nodules number						Nodule fresh weight (mg/plant)						Nitrogenase activity (µmole C_2H_4/g dry nod.)					
		2015			2016			2015			2016			2015			2016		
		45	75	Mean	45	75	Mean	45	75	Mean	45	75	Mean	45	75	Mean	45	75	Mean
Nubaria 1	T1	117	120	118.5	120	121	120	2379	2400	**2390**	3094	3110	**3269**	0.50	0.61	**0.555**	0.55	0.64	**0.595**
	T2	209	211	210	221	225	223	1282	1296	**1289**	3258	3280	**3102**	0.65	0.74	**0.695**	0.69	0.75	**0.720**
	T3	118	124	121	210	220	215	1108	1115	**1112**	1779	1808	**1794**	0.70	0.75	**0.725**	0.99	1.15	**1.070**
	T4	206	210	208	119	112	115	2232	2240	**2236**	1990	2112	**2051**	0.65	0.70	**0.675**	0.80	1.00	**0.900**
	T5	54	60	57	56	65	60	579..8	622	**601**	543.0	600.2	**572**	0.43	0.50	**0.440**	0.47	0.55	**0.510**
	T6	53	62	57.5	58	63	60	559..2	600	**579.6**	524.0	595.0	**560**	0.41	0.45	**0.430**	0.44	0.52	**0.480**
Mean		**127**	**131**	**129**	**129**	**134**	**132**	**1357**	**1750**	**941**	**1865**	**1918**	**1892**	**0.557**	**0.625**	**0.591**	**0.657**	**0.768**	**0.713**
Nubaria 2	T1	119	122	120.5	121	125	123	2920	3001	2961	3551	3605	**3578**	0.45	0.48	**0.465**	0.52	0.58	**0.550**
	T2	218	222	222	223	230	226	1681	1754	1718	2196	2210	**2203**	0.51	0.60	**0.555**	0.55	0.61	**0.580**
	T3	218	226	220	220	226	223	1467	1504	1486	1927	2110	**2019**	0.60	0.68	**0.640**	0.72	0.89	**0.805**
	T4	121	124	122.5	218	225	221	2805	2945	2875	3428	3502	**3465**	0.56	0.61	**0.585**	0.70	0.76	**0.730**
	T5	62	85	73.5	65	80	72	615.8	723.1	669	740.4	814.2	**777.3**	0.38	0.39	**0.385**	0.42	0.47	**0.445**
	T6	62	72	67	63	65	64	593.9	611.2	603	707.9	756.0	**732**	0.30	0.35	**0.325**	0.35	0.40	**0.375**
Mean		**133**	**141**	**136**	**151**	**158.5**	**155.5**	**168.0**	**1756**	**1700**	**2092**	**2166**	**2129**	**0.467**	**0.518**	**0.493**	**0.543**	**0.618**	**0.581**
LSD (0.05)		**V: 2.67**			**5.68**			**10.93**	**10.93**		**0.05**			**0.024**	**0.024**		**0.05**		
		T: 3.08			**4.28**			**6.93**	**6.93**		**0.04**			**0.040**	**0.040**		**0.04**		
		VT: NS			**NS**			**0.003**	**0.003**		**NS**			**0.050**	**0.050**		**NS**		

T: treatment V: variety VT: interaction between treatment and varsity

The total count of bacteria, fungi and actinomycetes in addition to the dehydrogenase and nitrogenase enzymes activity were determined (Table, 4). The obtained data show that the total count of bacteria, fungi and actinomycetes were higher in the rhizosphere of the 75-day old plants than in the 45-day old plants. Higher counts as well were recorded in the rhizosphere of all plants compared with fungi and actinomycetes. In both seasons, compost- treated soil cultivated with either plant genotypes harbored the highest counts of all microorganisms followed by compost tea treated soil. Most probably compost and compost tea triggered multiplication of all soil microorganisms due to the nutritive components in addition to their natural microbial flora. Compost resulted in 18 , 21 and 57 and 58 x 10^5 *cfu*/ g of total bacteria, 25 , 29 and 422, 425 x 10^3 *cfu*/ g of total fungi and 31, 39 and 85, 182 *cfu*/ g of total actinomycetes for the 45 and 75day old Nubaria 1 plants in the two seasons, respectively. A similar trend was observed with Nubaria 2. Compost tea and PGPR treatment achieved the highest numbers of total bacteria, fungi and actinomycetes in rizospher barley plant in sandy soil (Heba, *et al*., 2014).

The dehydrogenase activity was increased due to compost application over other treatments when determined at 45 and 75 days after sowing. The dehydrogenase activity during the season 2016 exhibited higher values than 2015. The maxima dehydrogenase activity (24.6 and 28.15 µTPF/g) were estimated in compost-treated soil cultivated with variety Nubaria 2. Dehydrogenase activities determined after 75 days were significantly higher than those estimated after 45 day representing 18.5 and 21.2 µTPF/g soil during season 2015 and 2016, respectively as shown in table, 4.

Meanwhile, humic and fulvic acids were superior for increasing nitrogenase activities in all plant rihizosphers during 2015 and 2016. Both amendments resulted in significantly higher values of N_2-ase activities with Nubaria 2 than Nubaria 1 recording 22.6 and 41.6 µ mole C_2H_4/g. Moreover, N_2-ase through period 75 day was higher than 45 day its obtained 19.4 and 30.5 µ mole C_2H_4/g during season 2015 and 2016 respectively. Humic substances when tested with 75% NPK gave the highest activities of both nitrogenase and dehydrogenase enzymes at 75 days from sowing of wheat plant respectively, as reported Massoud *et al.* (2013). Also, Afifi, *et al*. (2014) found that nitrogenase, dehydrogenase and phosphatase enzymes activities increase with combined mixture treatment (*Azospirillum brasilense*, *Bacillus megaterium* and *Bacillus circulans*) cells plus humic acid after 45 and 75 days of sowing sorghum.

4- Effect of treatments on properties of calcareous soil

Data in table (5) show no sharp changes in the pH and EC values sharp but they are Nearly the same values estimated either with Nubaria 1 or Nubaria 2. Nevertheless, obvious changes in the amount of available nitrogen in particular for fulvic acid treated foliar recording 96 and 100 ppm with both varieties in 2016, respectively. The organic matter content in the soil amended with compost and humic acid was higher compared with the other treatments soaring 0.77, 0.91 and 98, 96 in compost-amended soil and humic acid-treated soil for the two varieties in 2016, respectively.

Table (4): Changes of some microbiological activities in the rhizosphere of two faba bean varieties treated with humic substances compost and compost tea after 45 and 75 days from sowing during the two seasons of 2015/2016 and 2016/2017.

Variety / Treatment		Total Bacterial Counts (10^5 cfu/g soil)				Total fungi (10^3cfu/g soil)				Total Actinomycetes (10^3 cfu /g soil)				Dehydrogenase activity (µg TPF/g dry rhizosphere)						Nitrogenase activity (µmole C_2H_4 /g dry rhizosphere					
		2015		2016		2015		2016		2015		2016		2015			2016			2015		Mean	2016		
		45	75	45	75	45	75	45	75	45	75	45	75	45	75	Mean	45	75	Mean	45	75		45	75	Mean
Nubaria 1	T1	18	21	57	58	25	29	422	425	31	39	85	182	21.2	23.4	**22.3**	24.1	26.0	**25.05**	13.5	17.9	**15.7**	16.3	20.4	**18.35**
	T2	14	20	24	26	18	20	121	123	25	31	112	114	16.6	18.8	**17.7**	13.4	17.4	**15.4**	18.5	22.9	**20.7**	16.4	20.3	**18.35**
	T3	12	18	13	14	19	27	112	114	29	32	182	87	17.6	19.8	**18.7**	12.4	15.20	**13.8**	16.6	20.8	**18.7**	23.1	43.4	**33.25**
	T4	16	20	49	50	24	33	419	421	31	36	176	180	19.7	21.9	**20.8**	20.1	25.7	**22.9**	17.8	21.9	**19.9**	20.4	42.7	**31.55**
	T5	11	13	6	7	12	14	73	75	16	18	34	36	5.3	7.5	**6.4**	6.5	11.3	**8.9**	5.4	9.8	**7.6**	6.2	7.2	**6.7**
	T6	11	12	5	5	12	13	69	72	15	15	18	20	4.8	6.9	**5.85**	5.4	11.0	**8.2**	4.8	8.6	**6.7**	6.1	7.4	**6.75**
Mean														**14.2**	**16.4**	**15.3**	**13.7**	**17.7**	**15.7**	**12.7**	**16.9**	**14.9**	**14.8**	**23.6**	**19.1**
Nubaria 2	T1	19	22	72	73	20	27	444	444	32	38	193	195	23.5	25.7	**24.6**	27.3	29.0	**28.15**	17.6	21.8	**19.7**	18.2	28.4	**23.3**
	T2	17	21	26	28	17	25	131	134	24	32	118	120	17.3	19.5	**18.4**	18.5	23.4	**20.95**	20.4	24.8	**22.6**	19.3	26.8	**23.1**
	T3	16	18	14	15	20	26	129	130	22	31	185	190	20.8	22.9	**21.8**	17.4	20.1	**18.75**	19.3	23.7	**21.5**	28.1	55.1	**41.6**
	T4	18	23	66	68	24	38	442	443	25	35	183	186	21.6	23.8	**22.7**	25.4	28.2	**26.8**	18.9	22.9	**20.9**	26.9	54.6	**40.8**
	T5	12	14	8	9	11	14	88	89	18	21	39	41	8.1	10.3	**9.2**	8.9	14.3	**11.6**	9.2	13.5	**11.4**	7.4	9.2	**8.3**
	T6	11	13	7	8	13	13	87	87	15	19	37	38	6.8	8.9	**7.85**	7.6	12.3	**9.95**	5.3	9.7	**7.5**	7.5	8.7	**8.1**
Mean														**16.4**	**18.5**	**17.4**	**17.5**	**21.2**	**19.4**	**15.1**	**19.4**	**17.3**	**17.9**	**30.5**	**24.1**
LSD (0.05)														**V:** 2.67 **T:** 3.08 **VT :1.021**			**V:** 2.70 **T:** 3.90 **VT :1.023**			**V:** 1.29 **T:** 3.32 **VT :0.021**			**V:** 4.34 **T:** 2.49 **VT :1.021**		

T: treatment V: varity VT: interaction between treatment and varity

Table (5): Some chemical properties of calcareous soil as affected by application of compost and compost extracts during seasons 2015/2016

Variety	Treatment	pH		EC		(NH^+_4-N and NO_3 – N) ppm		Organic Matter %		N%		P%		K%	
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Nubaria 1	T1	7.4	7.8	1.4	1.9	47	52	0.5	0.77	0.2	0.1	0.11	0.10	0.35	0.44
	T2	7.5	7.7	1.3	1.8	55	88	0.4	0.98	0.2	0.2	0.14	0.13	0.39	0.48
	T3	7.2	7.3	1.2	1.7	68	96	0.6	0.70	0.2	0.3	0.14	0.16	0.41	0.56
	T4	7.2	7.3	1.1	1.7	61	92	0.6	0.61	0.2	0.2	0.11	0.15	0.40	0.54
	T5	7.5	7.6	1.3	1.8	60	70	0.3	0.70	0.1	0.1	0.10	0.09	0.36	0.43
	T6	7.4	7.2	1.3	1.9	59	63	0.2	0.40	0.1	0.1	0.08	0.08	0.29	0.41
Nubaria 2	T1	7.6	7.6	1.5	1.8	49	60	0.6	0.91	0.2	0.1	0.13	0.12	0.31	0.47
	T2	7.7	7.7	1.6	1.6	61	95	0.6	0.96	0.1	0.2	0.16	0.15	0.41	0.52
	T3	7.4	7.2	1.4	1.6	71	100	0.7	0.9	0.1	0..3	0.15	0.19	0.42	0.60
	T4	7.5	7.1	1.5	1.7	55	98	0.4	0.9	0.2	0.2	0.12	0.17	0.35	0.58
	T5	7.6	7.5	1.7	1.7	53	78	0.4	0.7	0.2	0.1	0.11	0.12	0.31	0.48
	T6	7.2	7.1	1.7	1.8	51	70	0.3	0.6	0.1	0.1	0.10	.010	0.27	0.44

Unexpectedly, the highest NPK values were recorded in the fulvic acid- and compost tea-treated soil. The variety Nubaria No.1 grown in the soil amended with fulvic acid and compost recorded 0.3, 0.15 and 0.56% of NPK respectively (Table, 5). A similar trend could be observed with respect to shoot NPK contents as the soil treated with fulvic acid and compost tea showed enhanced uptake of shoot NPK than the other treatments. This might be due to the growth promoting effects of fulvic acid and compost tea which enhanced uptake of NPK by the examined varieties. Perhaps the improved root growth as a result of these two amendments enhances water and nutrient uptake by both plant genotypes.

5- Contents of NPK in faba bean shoots

Data in table (6) show that the values of total nitrogen in Nubaria 1 and Nubaria 2 plants received fulvic acid were 4.01, 3.79 and 4.10, 4.12 % in 2015 and 2016, respectively. Compost tea resulted in total nitrogen values corresponding to 4, 3.75 was and 4.05, 4.1, respectively. Total phosphorus was 0.25, 0.28 and 0.29, 0.31 % in plants treated with fulvic acid during both seasons with two verities.

Table (6): Effect of compost, humic and fulvic acids and compost tea on the contents of total nitrogen, phosphorus and potassium % in *faba bean* shoots during season 2015/2016

Variety	Treatment	Total N %		Total P %		Total K %	
		2015	2016	2015	2016	2015	2016
Nubaria 1	T1	2.81	2.86	0.15	0.17	2.60	2.64
	T2	3.90	3.38	0.20	0.22	2.80	2.85
	T3	4.01	3.79	0.25	0.28	3.50	3.66
	T4	4.00	3.75	0.24	0.27	3.35	3.40
	T5	2.60	2.45	0.14	0.15	2.44	2.47
	T6	2.25	2.20	0.12	0.14	2.35	2.39
Nubaria 2	T1	3.15	3.20	0.18	0.19	3.20	3.25
	T2	3.95	4.00	0.21	0.23	3.31	3.37
	T3	4.10	4.12	0.29	0.31	3.66	3.69
	T4	4.05	4.10	0.25	0.29	3.64	3.68
	T5	2.90	2.95	0.14	0.16	3.12	3.17
	T6	2.40	2.46	0.12	0.15	2.94	2.98

Meanwhile, the total potassium achieved with foliar application of Fulvic acid 3.5, 3.66 and 3.69 % with two verities in 2015 and 2016 seasons, respectively as shown in Table(6). Tan (1982) studied the effect of HA and FA in sand cultures on growth of soybeans (*Glycine max* L.), peanuts (*Arachis hypogea* L.) and clover plants. In general, shoot, root, and nodule dry weights showed a tendency to increase in response to treatments with 100 to 400 mg FA or HA kg^{-1} soil.

6- Percentages of NPK in faba bean grains

Increase NPK with FA treatment either in soil or plant uptake was reflected their increase in seeds as shown in table (7). Total NPK were the highest in seeds with variety Nubaria 1 achieved 4, 0.42 and 1.35 % for T3, whereas, they were 4.82, 0.94 and 1.33% with variety 2 during final season of experiment. Increase total nitrogen content in seeds reflects increase of protein content in two verities 25 and 30.13% during final season respectively.

Table (7): Effect of compost and compost extracts on NPK percentages of faba bean grains during seasons 2015/2016.

Variety	Treatment	Total N %		Protein %		Total P %		Total K %	
		2015	2016	2015	2016	2015	2016	2015	2016
Nubaria 1	T1	2.40	3.41	15.00	21.31	0.16	0.21	1.11	1.17
	T2	2.60	3.63	16.25	22.69	0.18	0.23	1.13	1.20
	T3	3.88	4.00	24.25	25.00	0.32	0.42	1.22	1.35
	T4	3.41	3.95	21.31	24.69	0.28	0.40	1.20	1.34
	T5	3.00	3.25	18.75	20.31	0.15	0.18	1.10	1.17
	T6	2.94	3.10	18.38	19.38	0.13	0.17	1.03	1.08
Nubaria 2	T1	3.69	3.82	23.06	23.88	0.31	0.70	1.14	1.22
	T2	3.92	4.02	24.50	25.13	0.51	0.82	1.12	1.26
	T3	4.11	4.82	25.69	30.13	0.57	0.94	1.44	1.33
	T4	3.13	4.75	19.56	29.69	0.53	0.92	1.39	1.32
	T5	3.10	3.52	19.38	22.00	0.26	0.30	1.12	1.16
	T6	2.95	3.30	18.44	20.63	0.21	0.25	1.07	1.15

CONCLUSION

Use of organic fertilizers in calcareous soils have key role in enhancement physiochemical and biological soil properties as well as increase productivity beside to, limit soil pollution and low cost.

REFERENCES

Abou El-Magd, M.M.; El-Bassiony, M. and Fawzy, Z.F. (2006): Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of broccoli plants. J. Appl. Sci. Res., 2 (10): 791-798.

Afifi, M.M.I. (2010): Biochemical Studies on Humic Substances Extracted from Organic Fertilizers. ph.D. Thesis Fac. Agric., Cairo, Univ., Egypt, 157 p.

Afifi, M.M.I.; El-Sayed, G.A.M.; Manal, A.H.E. and Massoud, O.N. (2014): Synergistic effect of biofertilizers containing N -fixer, P and K solubilizers and humic substances on *Sorghum bicolor* Productivity. Middle East Journal of Applied Sciences, 4 (4): 1065- 1074.

Ahmed, M.A. and El-Abagy, H.M.H. (2007): Effec to bio-and ineral phosphorus fertilizer on the growth ,productivity and nutritional value of some faba bean (*Vicia faba* L.) cultivars in newly cultivated .J .Appl.Sci.Res.,3:408-420.

Alghamdi, S.S. (2007): Genetic Behavior of Some Selected Faba Bean Genotypes. Proc. 8th Conf. African Crop Sci., El-Minia, Egypt. pp. 709-714.

Allen, O.N. (1959): Experiments in Soil Bacteriology.1st ed. Burges Publ. co. Minnesota USA, 117 p.

APHA, (American Public Health Association) (1989): Municipal Refuse Disposal 3rd Ed. Public Administration Service, Chicago. https://www.mwa.co.th/download/file_upload/SMWW_1000-3000.pd.

Ayoola, S.R. and Makinde, E.A. (2009): Maize growth, yield and soil nutrient changes with N-enriched organic fertilizers. African J. Food Agric. Nut. and Develop., 9(1): 580-592.

Black, C.A.; Evans's, D.O.; Ensmunger, L.E.; White, J.L.; Clark, F.E. and Dineure, R.C. (1982): Methods of Soil Analysis II, Chemical and Microbiological Properties. American Soc. Argon. Madison, Wisconsin, USA, 1572 P.

Brinton, W.; Storms, P.; Evans, E. and Hill, J. (2004): compost teas microbial hygiene an quality in relation to method of preparation. Woods End Research Laboratory reprint from J. Compost Science and Utilization 12(1): 93-96.

Chapman, H.D. and Pratt, F.P. (1961): Methods of analysis for soils, plants and water. Univ. of Califonia, Div. of Agric.Sci.conditions. Ann. Agric. Sci., In press No. 309P.

Dragunova, A.F. (1958): A rapid method for determining functional groups in humic acids. Nauch. Trudy, Mosk. In Zh. Chonon Inst. Ser. Khinprioz-vod., 110. c.f.Kononova (1966) ttps://books.google.com.eg/books?isbn=1483185680.

Farag, H.I.A. and Afiah, S.A. (2012): Analysis of gene action in diallel crosses among some faba bean (*Vicia faba L.*) genotypes under Maryout, 57 (1): 37-46.

Goh, K.M. and Stevenson, F.J. (1971): Comparison of infra-red spectra of synthetic and nutral humic and fulvic acids. Soil Sci., 112: 392-400.

Habashy, N.R.; Amal, W.A. and Rafat, N.Z. (2008): Effect of organic and biofertilizers on phosphorus and some micronutrients availability in a calcareous – soil. Res. J. Agric. & Biol. Sci., 4(5): 452-462.

Heba M.A. Khalil; Afifi, M.M.I.; El-Akshar, Y.S. and Mahmoud, Y.I. (2014): Biodynamics for controlling of weeds using bio-organic fertilizers with rice straw and improve productivity barley plants in sandy soil . International Journal of Academic Research Vol. 6 (6) November, 237-244.

Huck, T.; Porter, A. and Bushell, N. (1991): Effect of humates on microbial activity Micro. Eng. J. Gen. Microbiol., 137 (10): 2321 -2329.

Ingham, E. (2005): "The Compost Tea Brewing Manual". 5th Ed., Soil Food web Incorporated, Oregon, Aust., 79p.

Jakson, M.L. (1973): Soil Chemical Analysis. Prentic-Hall of India Private Limited, New Delhi, pp175-285.

Kim, H.T. (2014): Humic Matter in Soil and Environment Principles and Controversies. CRC PressTaylor & Francis Group6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742. Book 439 P.

Kononova, M.M. (1966): Soil Organic Matter. Pergmon Press, Oxford, London, Edinburgh, New York 544P.

Lulakis, M.D.; Petsas, S.I. (1995): Effect of humic substances from vine-canes mature compost on tomato seedling growth .Bioresour .Technol 54: 179–182.

Mahmoud, Y.I.; Abdelaziz, A. and Alkahal, A.A. (2012): The feasibility of composting olive mill solid residues with various agricultural wastes. International Journal of Academic Research Vol. 4(1): 158-167.

Martin, J.P. (1950): Use of acid Rose Bengal and Streptomycin in the plate method for estimating soil fungi. Soil Sci., 69: 715-732.

Massoud, O.N.; Afifi, M.M.I.; El-Akshar, Y.S. and El-Sayed, G.A.M. (2013): Impact of biofertilizers and humic acid on the growth and yield of Wheat grown in reclaimed sandy soil. Research Journal of Agriculture and Biological Sciences, 9(2): 104-113.

Murphy, J. and Riley, J.P. (1962): A modified signle solution method for the determination of phosphatic in natural water. Anal. Chem. Acta., 27: 31-36.

Neveen, B. Talaat and Amany, M. Abdallah (2008): Response of Faba Bean (*Vicia faba* L.) to Dual Inoculation with Rhizobium and VA Mycorrhiza under Different Levels of N and P Fertilization. Journal of Applied Sciences Research, 4(9): 1092-1102.

Oad, F.C.; Buriro, U.A. and Agha, S.K. (2004): Effect of organic and inorganic fertilizer application on maize fodder production. Asian J. Plant Sci., 3: 375-377.

Page, A.L.; Miller, R.H. and Keeney, D.R. (1982): Methods of Soil Analysis. Chemical and Microbiological Properties,2ed Edition Madison Wlsconsim. USA, pp: 663.

Rosa, C.M.; Castilhos, R.M.; Vahl, V.L.C. and Costa, P.F.P. (2004): Effect of fulvic acids on plant growth, root morphology and macronutrient uptake by oats. In: "Humic Substances and Soil and Water Environment", São Pedro, Proceedings São Pedro: Embrapa Instrumentação, pp.

Russo, R.O. and Berlyn, G. (1990): The use of organic biostimulants to help low input sustainable agriculture. J. Sust. Agric., 1: 19-42**.**

Said, M.K.; Mohamed, M.I.A.; Fathia S.E. and Mohamad, M.S. (2014): Fulvic acid: a tool for controlling powdery and downy mildews in cucumber plants. Int. J. Phytopathol. 3 (2): 101-108.

Sanchez-Monedero, M.A.; Roid, A.; Cegarra, J.; Bernal, M.P. and paredes, C. (2002): Effects of HCL-HF purification treatment on chemical composition and structure of humic acids. Eur. J. Soil Sci., 53: 375-381

Sant'anna, S.A.C.; Fernandes, M.F.; Ivo W.M.P. and Costa, J.L.S. (2009): Evaluation of soil quality indicators in sugarcane management in sandy loam soil. Pedosphere 19(3): 312–322.

Scheuerell, S.J. and Mahaffee, W.F. (2002): Compost tea: Principles and prospects for plant disease control. Compost Sci. Utiliz., 10: 313-338.

Schintzer, M. and Gupta, U.C. (1965): Determination of acidity in soil organic matter. Soil Sci. Soc. Amer. Proc, 29: 274-277.

Somasegaran, P. and Hoben, H.J. (1994): In: Hand Book for Rhizobia" Springer Veriag. New York. USA, p 215.

Steel, R.G.D. and Torrie, J.H. (1982): Principles and Procedures of Statistics: A Biometrical Approach. Mcgraw-Hill Publishing Co., London, UK., Pages: 625p.

Stevenson, F.J. (1994): Humus Chemistry: Gensis, Composition, Reaction. 2nd .John Wiley&Sons, New York 496 P.

Tan, K.H. (1982): Principles of Soil Chemistry. Marcel Dekker,Inc., New York, NY, 267 p.

Tejada, M.; Hermendez, M.T. and Carcia, C. (2006): Application of two organic amendments on soil restoration: Effects on the soil biological properties J. Environ. Qual., 35: 1010-1017.

Waller, R.A. and Duncan, D.B. (1969): A bayes rule for the symmetric multiple comparisons problem. J. Am. Stat. Assoc., 64: 1484-1503.

Williams, S.T. and Davis, F.L. (1965): Use of antibiotics for selected isolation and enumeration of actinomycetes in soil. J. Gen. Microbiol., 38: 251-261.

استجابة نباتات الفول البلدى للاضافات العضوية بالتربة الجيرية

للسادة الدكاترة

محمد محمود ابراهيم عفيفى[1] ، ياسر سعد الاكشر[1]، يحى ابراهيم محمود زين[1] و رحاب احمد عبد الرحمن[2]

مـــن

معهد بحوث الاراضى والمياة والبيئة – مركز الحوث الزراعية – مصر

معهد بحوث المحاصيل الحقلية مركز الحوث الزراعية – مصر

يعتبر الفول البلدى من المحاصيل البقولية الشتوية الاساسية بمصر حيث يعتبر مصدرا للبروتين بالاغذية والاعلاف . يتاثر نمو ومحصول الفول البلدى تاثرا كبير بالخواص الفيزيائية والكيميائية للارض الجيرية.

اجريت تجربتين حقليتين بمحطة بحوث النوبارية اثناء موسمين 2016/2015 و 2017/2016 لدراسة تاثير الامدادات العضوية المختلفة على النمو ،تكوين العقد الجذرية ، المحصول و امتصاص العناصر بالنبات لصنفين من الفول البلدى وهما نوبارية 1 ونوبارية 2 . والاسمدة العضوية هى الكمبوست ، حامض الهيوميك، وحامض الفالفيك وشاى الكمبوست. اظهرت النتائج ان حامض الهيوميك مع 50% من التسميد المعدنى (NPK) حقق اعلى زيادة معنوية فى طول النبات وعدد الافرع فى كلا الصنفين اثناء الموسمين .واعطت معاملة حامض الفالفيك مع التسميد المعدنى 50% اعلى زيادة معنوية فى المحصول حيث اعطت 9.38 و 11 اردب / للفدان لصنفين نوبارية 1 ونوبارية 2 على التوالى. وكان محصول الصنف نوبارية 1 أعلى من محصول الصنف نوبارية 2 فى كلا الموسمين.وسجلت معاملتيى الهيوميك والكمبوست زيادة معنوية فى الوزن الطازج وعدد العقد الجذرية. كما زادت الاعداد الكلية من البكتريا والفطريات والاكتينوميستات بالاضافة لزيادة نشاط انزيم الدهيدروجينز مع معاملتى الكمبوست وشاى الكمبوست. فى حين ادت معاملة حامض الهيوميك الى زيادة نشاط انزيم النيتروجينز بطريقة اختزال الأستيلين اثناء موسم 2016/2015 .وعلى النقيض معاملة حامض الفالفيك حسنت نشاط انزيم النيتروجينز بموسم 2017/2016. وزاد الممتص من الـ NPK فى كلا من السيقان والحبوب مع معاملة حامض الفالفيك. كما زادت معاملة حامض الفالفيك نسبة البروتين زيادة معنوية فى محتوى الحبوب فى كلا الموسمين مع الصنفين .