Maize Productivity using Soil Amendments, Mineral and Bio- fertilization

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ABSTRACT: Two field experiments were conducted at the private farm at El- Nubaria, El-Behria, Egypt, during the summer seasons of 2017 and 2018 to study the response of the maize hybrid TWC 310 to soil amendments and mineral + biofertilization. Split plot design with three replications was used, where the main plots occupied by soil amendments (soil application of Sulfur (S) at the rate of 100 kg/fed, Humic acid with irrigation water (3 kg/fed) and soil application of Fluvic acid (2 kg/fed) and soil application of compost at the rate of 5 t/fed), meanwhile the sub plots contained mineral NPK fertilizers with bio- fertilizers of NPK (100% mineral NPK, 75 % mineral NPK + bio- fertilizers, and bio- fertilizers of NPK) in both seasons. The obtained results indicated that using compost, fulvic acid, and humic acid with mineral NPK (75% of recommended dose) with biofertilizer fertilizers increased yield and its components of maize under El- Nubaria Region.
Keywords: Soil amendment, Sulfur (S), humic acid, Fulvic acid, compost, mineral, biofertilizer, maize productivity.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in Egypt and in the world. The area devoted to maize cultivation in Egypt is about 1.1 million hectares with an average yield about 7.4 t/ha. But in the world the area for maize reached 188 million hectares with an average yield about 5.6 t/ha (FAO, 2016).

Bio fertilization is an important factor being used to produce without some mineral fertilizer that cause environmental pollution problems and high rates of it leads to decrease the potential activity of microbial and the mobility of organic matters. Hence, the attention has been focused on the researches of biofertilization to safe alternative specific chemical fertilizers. Meanwhile, *Rhizobium radiobacter* could be isolate in high salinity soil. The bacterial growth promoting enhances nitrogenase activity and production of indole acetic acid (IAA), gibberellic acid (GA3) and abscisic acid (ABA) under osmotic stresses (Moussa and Youssef, 2012). *Rhizobacteria* improve plant growth employing a variety of growth promoting mechanisms including nutrient uptake, root growth, proliferation, biocontrol activities, and Indol Acetic Acid (IAA) producing, phosphate solubilizing bacterial strain. Also, that in fully fertilized control plants, biomass was high and grain yield was low while addition of halotolerant PGPR with half fertilization exhibited higher grain yield as compared to biomass (Rajput *et al*., 2013).

Fulvic acid is applied to the soil enhancement of root initiation and increased root growth (Pettit, 2004). Fulvic acid as an organic fertilizer, is a non-toxic mineral chelating additive and water binder that maximizes uptake through leaves and stimulates plant productivity (Malan, 2015).

Humic acids (HA) is an important constituent of soil organic matter which enhances the growth and yield of crops and improves soil physical and chemical characteristics (Khan *et al*., 2012). It is particularly used to ameliorate or reduce the negative effects of salt stress. Humic acids contributes to plant growth through its effect not only on the physical and chemical but also on biological properties of the soil. It is mainly a nutritional function, as it serves as a source of N, P, and cations for plant growth (Arancon *et al.,* 2006).On other hand, Organic fertilizers (Ahmed and Moritani, 2010) or liquid, such as biofertilizers and humic substances employed in reducing the risks of salts, the interaction between salinity and mineral fertilization with nitrogen and potassium should also be evaluated in mitigating the harsh effects of the salts to the plants (Prazeres *et al*., 2015).Also, compost, which may be defined as the stabilized and sanitized product of composting, which is compatible and beneficial to plant growth Application of compost has a positive effect on basic soil properties (physical, chemical, and biological fertility). Composition of the input substrate has a significant effect on compost quality (Diaz *et al.,* 2007).

Sulfur is an essential element for plant growth as it helps in synthesis of peptides, which contain cysteine like glutathione, various secondary metabolites (Scherer *et al*., 2008 and Abdallah *et al.*, 2010) vitamins (B, biotine and thiamine) and chlorophyll in the cell (Kacar and Katkat, 2007). Sulfur not only increasing crop production and quality of the produce, but also improves soil conditions for healthy crop growth (Abdou, 2006 and El-Tarabily *et al.,* 2006). S fertilizer application in salt affected soils is a viable procedure to counteract uptake of unnecessary toxic elements (Na^+ and Cl^-), which encourage selectivity of K/Na and ability of calcium ion to decrease the harmful impacts of sodium ions in plants (Wilson *et al*., 2000 and Zaman *et al*., 2002). Elemental sulfur is considered as an adequate and cost-effective amendment for sodic-saline soils (Tarek *et al.,* 2013) and recommended when soil pH exceeds 6.6 for the purpose of reducing pH this changes in soil pH can mobilize nutrients from unavailable phases to available pools, therefore increasing P and micronutrient availability (Wei *et al.,* 2006 and Rice *et al*., 2006). Application of sulfur in soil achieved highest quantity of available phosphorus for flood and drip irrigation system, increased Phosphorous uptake in plant curde, achieved highest quantity of P uptake and increased dry matter product, and achieved highest dry matter yield (Sallum and Ali, 2011). Addition of sulfur is very effective technique to suppress the uptake of undesired toxic elements and to improve the quantity and quality of produce in salt affected soils. So, a three-year field experiment was carried out to evaluate the comparative reclamation efficiency of two sulfur sources, i.e., sulfur and gypsum to reduce the salinity/sodicity impact and yield characters of crops. Varying levels of sulfur and gypsum significantly improved soil properties and rice-wheat yield than control (Ahmed *et al.,* 2016).

The aim of this investigation was designed to study the response of maize to soil amendments and mineral + biofertilizer fertilizers.

MATERIALS AND METHODS

Two field experiments were conducted at El- Nubaria, El- Behria, Egypt, during 2017 and 2018 seasons to study the response of the maize hybrid TWC 310 to soil amendments and mineral + biofertilizer fertilizers.
The preceding crop was Egyptian clover (berseem) in the first season and second season.

Representative soil samples were taken from experimental soil before starting experimental work. The soil samples were air dried, passed through a 2 mm sieve, and then analyzed according to the method described by Page *et al.* (1982). The soil type of experimental site was clay loamy. The mechanical and chemical analysis of the experimental site is presented in Table (1).
Split plot design with three replications was used, where the main plots occupied by soil amendments (soil application of Sulfur (S) at the rate of 100 kg/fed, Humic acid with irrigation water (3 kg/fed), soil application of Fulvic acid (2 kg/fed) and soil application of compost at the rate of 5 t/fed, Table 2), meanwhile the sub plots contained mineral without/with biofertilizer fertilizers (100% mineral NPK, 75 % mineral + bio- fertilizers, and bio- fertilizers) in both seasons.

Each sub plot consisted of 6 ridges 3.50 m in length and 0.7 m in the width and plot area was 14.7 m^2. Inoculation with Nitrobein, a nitrogen fixing bacteria (*Azotobacter choroccocum* and *Azospirellum braselines*), phosphorein (*Bacillus megtherium phosphacterium) a* phosphorus dissolving bacterium and potasiumage of potassium mobilizing bacteria were performed by coating maize grains with each product individually using a sticking substance (Arabic gum) just before sowing. The biofertilizer was produced by General Organization for Agriculture Equalization Ministry of Agriculture and Land – Reclamation, Egypt (Abou El- Naga, 1993).

Table (1). Some Physical and chemical properties of the experimental soil in 2017 and 2018 seasons

Soil properties	Seasons	
	2017	2018
A) Mechanical analysis:		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
pH (1:1)	8.30	8.20
EC (dS/m)	3.70	3.80
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.53	1.54
Ca^{++}	9.30	9.10
Mg^{++}	18.30	18.50
Na^+	13.50	13.80
2) Soluble anions (1 : 2) (cmol/kg soil)		
CO_3^{--}+ HCO_3^-	2.80	2.70
Cl^-	20.40	19.90
SO_4^{--}	12.60	12.80
Calcium carbonate (%)	6.50	6.60
Total nitrogen (%)	1.00	0.92
Available phosphorus (mg/kg)	3.80	3.90
Organic matter (%)	1.42	1.41

Table (2). Composition of organic manures (compost)

Determination	Compost
Moisture (%)	10.70
Organic matter (%)	45.30
Total N (%)	1.90
Total P (%)	1.70
Total K (%)	1.10
pH (1:1)	6.53
EC (dS/m)	1.40
Fe (mg/ kg)	2660
Zn (mg/kg)	55.00
Mn (mg/kg)	280.00
Cu (mg/kg)	12.50

The sowing date was 15th May in both seasons. Field was hand thinned before the first irrigation to one plant/hill. The experimental units were hand hoed twice for controlling weeds before the first and second irrigations. Other agricultural practices were done as recommended by the Ministry of Agriculture. Ammonium nitrate (NH_4NO_3 – 33.50 N %) at the rate of (120 kg N/fed=100 %) and (90 kg N/fed= 75%) was used as N source which was applied in two equal doses, the first dose was before the first irrigation and the second one was before the second irrigation during seasons. P fertilizer was applied before planting in the form of Calcium super phosphate (15.5 % P_2O_5) at the rate of 24 kg P_2O_5/fed=100%) and (18 kg P_2O_5/fed=75%). Potassium sulphate (48% K_2O) as source of K at the rate of 24 kg K_2O/fed=100%) and (18 kg K_2O/fed=75%).
At harvest, plant height (cm), ear length (cm), number of rows/ear, number of grains/row, number of grains/ear, 100- grain weight (g), biological yield (t/ha), straw yield (t/ha), grain yield (t/ha), harvest index (HI) and protein content were recorded in both seasons.

Protein percentage was determined according to the improved Kyledahl methods of Association of Official Agricultural Chemists (AOAC, 1990), crude protein percentage was calculated by multiplying the total nitrogen for each sample by 6.25. Data were statistically analyzed as split plot design according to Gomez and Gomez (1984), using the split- model obtained by CoStat 6.311 (1998-2005) as statistical program. Treatment Average were compared according to LSD test at 0.05 level of probability to estimate the significant differences among treatments.

RESULTS AND DISCUSSION

Results in Table (3) reveals the effect of soil amendments, NPK- fertilizer sources (mineral and bio) and their interactions on plant height (cm), ear length (cm), number of rows/ear, and number of grains/row of maize during 2017 and 2018 seasons. Different soil amendments significantly affected the plant height at harvest, ear length and number of grains/row of maize during 2017 and 2018 seasons. Application of compost recorded the longest plants height but it had no significant difference among the others soil amendments as compared with sulfur which gave the shortest plants, while compost treatment gave the longest ear were (17.9 and 18.8 cm), and the highest value of number of grains/row (39.5 and 38.5) followed by fulvic acid and humic acid, which had no significant with compost while, application of sulfur recorded the lowest ear length (14.3 and 14.3 cm) and lowest number of grains/ear (30.8 and 31.5) in both season, respectively. These results were discussed by Anjum *et al.* (2011) who reported that fulvic acid and humic acid have been identified to regulate the plant growth under well- watered and drought conditions. Fulvic and humic substances behave similar to auxins, but it has not been confirmed either they contain auxin-like substances or not.

Results in Table (3) showed the significant effect of mineral and bio-fertilizer of NPK. Where, the highest mean values of plant height (173.3 and 184.6 cm), ear length (17.0 and 17.7 cm), and number of grains/ear (37.6 and 38.9) were obtained with 75% mineral NPK + biofertilizer with no significant difference between it and 100% mineral NPK in 2017 and 2018 seasons, respectively. While, the lowest values of plant height (152.3 and 156.0 cm), ear length (15.4 and 15.4 cm), and number of grains/row (31.4 and 31.3) were recorded under the grain inoculationby bio- fertilizer during both seasons, respectively. These results are in harmony with those obtained by Radwan and Nassar (2011) and Ghazal *et al.* (2013) who reported that combined bio-fertilizer with mineral fertilizer significantly increased maize yield and its components**.**

The interaction between soil amendments and NPK mineral and biofertilizer. Whereas, fulvic acid or compost with 75% mineral NPK + bio-fertilizer gave the longest plant height (179.5 and 194.6 cm), while compost + 75% mineral NPK + bio- fertilizer recorded the highest values of ear length (19.3 and 20.5 cm) and number of grains/row (43.5 and 42.4) in the first and the second season, respectively. While the lowest ones were recorded by sulfur + bio- fertilizers in both seasons.

Table (3). Maize attributes as affected by soil amendments, NPK mineral and biofertilizer during 2017 and 2018 seasons

	Treatments	Season 2017							Season 2018						
	A- Soil amendments	B- NPK mineral and biofertilizer: 100% mineral	75% NPK mineral and biofertilizer	Biofertilizer	Average	LSD at 0.05: A	B	AB	B- NPK mineral and biofertilizer: 100% mineral	75% NPK mineral and biofertilizer	Biofertilizer	Average	LSD at 0.05: A	B	AB
Plant height at harvest (cm)	Sulfur (S)	167.5	170.0	144.5	160.7b				161.6	179.3	148.5	163.1b			
	Humic acid	169.8	171.0	157.8	166.2ab				177.4	181.5	156.8	171.9a			
	Fulvic acid	164.5	179.5	151.3	165.1ab	5.8	4.9	10.0	193.1	184.3	159.8	179.1a	7.5	6.5	12.9
	Compost	175.8	172.8	156.3	168.3a				176.9	194.6	158.8	176.8a			
Average		169.4a	173.3a	152.5b					177.3b	184.9a	156.0c				
Ear length (cm)	Sulfur (S)	14.4	14.3	14.3	14.3c				14.4	15.6	13	14.3c			
	Humic acid	15.3	16.8	15.3	15.8b				16.9	17	15.8	16.6b			
	Fulvic acid	16.0	17.5	15.5	16.3b	0.90	0.78	1.55	18.1	17.7	15.9	17.2b	0.81	0.70	1.4
	Compost	18.0	19.3	16.4	17.9a				19.0	20.5	16.9	18.8a			
Average		15.9b	17.0a	15.4b					17.1a	17.7a	15.4b				
Number of row/ear	Sulfur (S)	14.0	14.0	13.3	13.8				14.0	14.0	13.3	13.8			
	Humic acid	14.0	14.5	14.0	14.2				14.0	14.5	14.0	14.2			
	Fulvic acid	14.0	14.5	15.0	14.5	ns	ns	ns	14.0	14.5	15.0	14.5	ns	ns	ns
	Compost	14.5	15.0	13.5	14.3				14.0	15.0	13.5	14.2			
Average		14.1	14.5	14.0						14.0	14.5	14.0			
Number of grains /row	Sulfur (S)	31.3	33.0	28.0	30.8c				31.2	35.8	27.5	31.5b			
	Humic acid	37.5	36.0	32.5	35.3b				40.3	38.8	32.8	37.3a			
	Fulvic acid	39.8	35.5	31.8	35.7b	1.6	1.4	2.8	41.9	38.6	34.0	38.2a	1.7	1.5	1.09
	Compost	41.8	43.5	33.3	39.5a				42.0	42.4	31.0	38.5a			
Average		37.6a	37.0a	31.4b					38.9a	38.9a	31.3b				

- Average of each factor designated by the same letter are not significantly different at 5% using least significant difference (L.S.D.)

ns: Not Significant at 0.05 level of probability.

Table (4) shows the effect of soil amendments, NPK- fertilizer sources (mineral and bio) and their interactions on number of grains/ear, 100- grain weight (g), biological yield (t/ha), straw yield (t/ha) of maize during 2017 and 2018 seasons.

Different soil amendments significantly affected the pervious traits of maize during 2017 and 2018 seasons. Application of compost recorded the highest value of number of grains/ear (568.5 and 554.5) but it had no significant difference among the others soil amendments as compared with sulfur which gave the lowest one, while humic acid recorded the highest weight of 100- grain (43.9 and 41.4 g) but fulvic acid gave the highest value of biological yield (17.7and 16.3 t/ha) and straw yield (10.1 and 9.1 t/ha) followed by humic acid while, application of sulfur recorded the lowest ones in both season, respectively. These results were discussed by Nardi *et al*. (2002), and Anjum *et al.* (2011) who reported that fulvic acid and humic acid have been identified to regulate the plant growth under well- watered and drought conditions. Fulvic and humic substances behave similar to auxins, but it has not been confirmed either they contain auxin-like substances or not.

The results in Table (4) showed the significant effect of mineral and bio-fertilizer of NPK. Where, 75% mineral NPK + biofertilizer recoded the highest mean values of number of grains/row (537.6 and 564.7), 100- grain weight (44.8 and 43.1 g), biological yield (16.7 and 15.5 t/ha) and straw yield (8.8 and 8.1 t/ha) with no significant difference between it and 100% mineral NPK in 2017 and 2018 seasons, respectively. While, the lowest ones recorded under the grain inoculation by bio- fertilizer during both seasons, respectively. These results are in harmony with those obtained by Radwan and Nassar (2011) and Ghazal *et al.* (2013) who reported that combined bio- fertilizer with mineral fertilizer significantly increased maize yield and its components. Also, Gomaa *et al*. (2015) indicated that application of mixture of compost + A- mycorrhizal, significantly increased grain yield and yield components and proline (%), whereas application of mixture of compost + A- mycorrhizal especially A-mycorrhizal was a most times greater of leaf water potential.

The interaction between soil amendments and NPK mineral and biofertilizer. Meanwhile, compost acid + 75% mineral NPK + biofertilizer recorded the highest values of number of grains/ear in both seasons and humic acid + 75% mineral NPK + biofertilizer gave the highest 100- grain weight (g) in the first season but in the second season the highest 100- grain weight gave with compost + 75% mineral NPK + biofertilizer and meanwhile the highest biological yield and straw yield were obtained by fulvic acid + 100% mineral NPK fertilizers in the first and the second season, respectively. While the lowest ones recorded by sulfur +100% mineral NPK fertilizers in both seasons.

Table (4). Maize attributes as affected by soil amendments, NPK mineral and biofertilizer during 2017 and 2018 seasons

	Treatments	Season 2017							Season 2018						
		B- NPK mineral and biofertilizer				LSD at 0.05			B- NPK mineral and biofertilizer				LSD at 0.05		
	A- Soil amendments	100% mineral	75% NPK mineral and biofertilizer	Biofertilizer	Average	A	B	AB	100% mineral	75% NPK mineral and biofertilizer	Biofertilizer	Average	A	B	AB
Number of grains /ear	Sulfur (S)	437.5	462.0	370.5	423.3c				436.8	501.2	364.2	434.1b			
	Humic acid	525.0	521.5	455.0	500.5b				564.2	562.1	458.5	528.3a			
	Fulvic acid	556.5	514.5	475.5	515.5b	29.6	25.6	51.3	585.9	559.3	506.8	550.7a	30.7	26.6	53.1
	Compost	605.0	652.5	448.0	568.5a				608	636	419.5	554.5a			
Average		531.0a	537.6a	437.3b					548.7a	564.7a	437.3b				
100- grain weight (g)	Sulfur (S)	37.6	40.0	37.3	38.3b				38.0	39.5	38.8	38.8b			
	Humic acid	41.8	48.4	41.6	43.9a				42.8	42.5	38.8	41.4a			
	Fulvic acid	39.0	44.0	36.3	39.8b	2.8	2.5	4.9	39.3	44.5	34.5	39.4ab	2.1	1.8	3.6
	Compost	42.6	46.8	33.5	41.0b				43.0	46.0	33.3	40.8ab			
Average		40.3b	44.8a	37.2c					40.8b	43.1a	36.4c				
Biological yield (t/ha)	Sulfur (S)	13.4	15.2	13.0	13.9c				12.6	13.9	12.0	12.8c			
	Humic acid	15.9	16.2	15.9	16.0b				14.6	15.7	15.2	15.2b			
	Fulvic acid	17.8	17.6	17.7	17.7a	1.2	1.0	2.0	15.2	17.1	16.7	16.3a	0.96	0.83	1.7
	Compost	16.4	17.7	14.2	16.1b				12.6	15.1	12.0	13.2c			
Average		15.9ab	16.7a	15.2b					13.8b	15.5a	14.0b				
straw yield (t/ha)	Sulfur (S)	7.6	8.5	7.2	7.8c				6.9	7.4	6.5	6.9c			
	Humic acid	8.6	9.1	9.1	8.9b				7.7	8.5	8.5	8.2b			
	Fulvic acid	11.0	9.4	9.8	10.1a	0.61	ns	1.05	10.3	9.2	7.8	9.1a	0.62	0.54	1.08
	Compost	7.6	8.1	7.2	7.6c				6.9	7.4	6.5	6.9c			
Average		8.7a	8.8a	8.6a					8.0b	8.1a	8.0a				

- Average of each factor designated by the same letter are not significantly different at 5% using least significant difference (L.S.D.)
- ns: Not Significant at 0.05 level of probability.

Results in Table (5) reveals the effect of soil amendments, NPK- fertilizer sources (mineral and bio) and their interactions on grain yield, harvest index and grain protein % of maize during 2017 and 2018 seasons.

The results in Table (5) reveal the significant effect of different soil amendments on these traits during 2017 and 2018 seasons. Application of compost acid recorded the highest values of grain yield (t/ha), harvest index and grain protein content, however the lowest ones were obtained by sulfurin in both season. These results were discussed by Nardi *et al*. (2002) and Anjum *et al.* (2011) who reported that fulvic acid and humic acid have been identified to regulate the plant growth under well- watered and drought conditions. Fulvic and humic substances behave similar to auxins, but it has not been confirmed either they contain auxin-like substances or not.

Results as shown in Table (5) showed the significant effect of mineral and bio- fertilizer of NPK. Where, the highest mean values of grain yield, harvest index and protein content were obtained with 75% mineral NPK + biofertilizer with no significant difference between it and 100% mineral NPK in 2017 and 2018 seasons. While, the lowest values were recorded under the grain inoculation by bio- fertilizer during both seasons, respectively. These results are in harmony with those obtained by Radwan and Nassar (2011) and Ghazal *et al.* (2013) who reported that combined bio- fertilizer with mineral fertilizer significantly increased maize yield and its components.Also, Gomaa *et al*. (2015) indicated that application of mixture of compost + A- mycorrhizal, significantly increased grain yield and yield components and proline (%), whereas application of mixture of compost + A- mycorrhizal especially A- mycorrhizal was a most times greater of leaf water potential.

The interaction between soil amendments and NPK mineral and biofertilizer. Meanwhile, fulvic acid or compost with 75% mineral NPK + bio- fertilizer NPK gave the heaviest grain yield (9.6 and 8.9 t/ha), while compost + 75% mineral NPK + bio- fertilizer NPK recorded the highest values of harvest index (54.2 and 51.0 %) and grain protein content (10.7 and 11.4) in the first and the second season, respectively. While the lowest ones obtainedby sulfur +100% mineral NPK fertilizers in both seasons.

CONCLUSION

From the above mentioned results under the conditions of this research it could be concluded that the economic fertilization treatment for best growth attributes and the maximum grain, straw and biological yields of the maize hybrid TWC 310 plants and a good quality resulted with using any one of soil amendments like compost or fulvic acid or humic acid with 75% mineral NPK and bio-fertilizers NPK which it can active the biological conditions under Nubaria Region.

Table (5). Maize attributes as affected by soil amendments, NPK mineral and biofertilizer during 2017 and 2018 seasons

	Treatments	Season 2017							Season 2018						
		B- NPK mineral and biofertilizer				LSD at 0.05			B- NPK mineral and biofertilizer				LSD at 0.05		
	A- Soil amendments	100% mineral	75% NPK mineral and biofertilizer	Biofertilizer	Average	A	B	AB	100% mineral	75% NPK mineral and biofertilizer	Biofertilizer	Average	A	B	AB
Grain yield (t/ha)	Sulfur (S)	5.8	6.7	5.8	6.1c				5.7	6.5	5.5	5.9b			
	Humic acid	7.3	7.1	6.8	7.1b				6.9	7.2	6.7	6.9a			
	Fulvic acid	6.8	8.2	7.9	7.6b	0.72	0.62	1.2	4.9	7.9	8.9	7.2a	0.42	0.37	0.74
	Compost	8.8	9.6	7.0	8.5a				5.7	7.7	5.5	6.3b			
Average		7.2a	7.9a	6.9b					5.8b	7.3a	6.7c				
Harvest index (HI%)	Sulfur (S)	43.3	44.1	44.6	44.0b				45.2	46.8	45.8	45.9ab			
	Humic acid	45.9	43.8	42.8	44.2b				47.3	45.9	44.1	45.8bc			
	Fulvic acid	44.0	46.6	37.9	42.8b	1.8	1.6	3.1	48.7	46.2	38.3	44.4c	1.5	1.3	2.6
	Compost	53.7	54.2	49.3	52.4a				45.2	51.0	45.8	47.3a			
Average		46.7a	47.2a	43.7b					46.6a	47.5a	43.5b				
Grain protein content (%)	Sulfur (S)	7.3	7.6	7.4	7.4c				7.5	8.2	7.8	7.8c			
	Humic acid	8.4	9.4	8.6	8.8b				9.1	9.2	9.7	9.3b			
	Fulvic acid	9.1	10.1	8.5	9.2b	0.54	0.46	0.93	9.6	9.7	9.2	9.5b	0.49	0.43	0.85
	Compost	10.5	10.7	8.3	9.8a				11.2	11.4	9.0	10.5a			
Average		8.8b	9.5a	8.2c					9.4a	9.6ab	8.9b				

- Average of each factor designated by the same letter are not significantly different at 5% using least significant difference (L.S.D.)

REFERENCE

Abdallah, M., L. Dubousset, F. Meuriot, P. Etienne, J.C. Avice and A.Ourry (2010). Effect of mineral Sulfur (S) availability on nitrogen and Sulfur (S) uptake and remobilization during the vegetative growth of *Brassica napus* L. J. Exp. Bot., 61(10):2335-2346.

Abdou, S.A. (2006). Effect of applied elemental sulfur and sulfur-oxidizing bacteria (*Paracoccus versutus*) into calcareous sandy soils on the availability of native and applied phosphorus and some micronutrients. The 18th World Congress of Soil Sci., Philadelphia, Pennsylvania, USA.

Abou El-Naga, S.H. (1993). Production of biofertilizers in Egypt. General organization for Agriculture Equalization Fund in Egypt (GOAFF), biological nitrogen fixation, non-legumes 6th international symp. 6-9 Sept, Ismailia Egypt. pp 158.

Ahmed, B.A. and M.I.S. Moritani (2010). Effect of saline water irrigation and manure application on the available water content, soil salinity, and growth of wheat. Agric. Water. Manage. 97(1):165-170.

Ahmed, K., G. Qadir, A.R. Jami, A.I. Saqib, M.Q. Nawaz, M.A. Kamal, and E. Haq (2016). Strategies for soil amelioration using Sulfur (S) in salt affected soils. Cercetări Agronomiceîn Moldova, 3(167): 5-16.

Anjum, S. A., L. Wang, M. Farooq, L. Xue and S. Ali (2011). Fulvic acid application improves the maize performance under well- watered and drought conditions. J. Agr. and Crop Sci., 197 (6), 409- 417.

AOAC (1990). Official Methods of Analysis, 15^{th} Ed., Association of Official Analytical Chemists, Inc., USA. manure. Annals. Agric. Res., 24:(3): 466-473.

Arancon, N.Q., C.A. Edwards, S. Lee and R. Byrne (2006). Effects of humic acids from vermicomposts on plant growth. European J. Soil Biol., 42:65-69.

CoStat 6.311, C. C. W. (1998-2005). Cohort software798light house Ave. PMB320, Monterey, CA93940, and USA. email: infoatcohort.com.http://www.cohort.com/DownloadCoStatPart2.html

Diaz, L. F., D.M. Bertoldi. and W. Bidlingmaier (2007). Compost science and technology; Elsevier: Boston, pp. 364,

El-Tarabily K.A., A.S. Abdou, E.S. Maher and M. Satoshi (2006). Isolation and characterization of sulfur oxidizing bacteria, including strains of Rhizobium, from calcareous sandy soils and their effects on nutrient uptake and growth of maize (*Zea mays* L.). Aus. J. Agric. Res., 57(1):101-111.

FAO (2016). Food and Agriculture Organization Statistics, FAOSTAT. *www.fao.org/faostat.*

Ghazal, F. M., M. B. A. El-Koomy, Kh. A. Abdel-Kawi and M. M. Soliman (2013). Impact of cyanobacteria, humic acid and nitrogen levels on maize (*Zea mays* L.) yield and biological activity of the rhizosphere in sandy soils. J. Am. Sci,, 9(2): 46-55.

Gomaa, M. A., F.I. Radwan, I. F. Rehab, E. E. Kandil and A. R. M. Abd El-Kowy (2015). Response of maize to compost and A-mycorrhizal under condition of water stress. Int. j. Environ., 4(4): 271-277

Gomez, W. K. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. (2nd edition). John Wiley and Sons. New York.

Kacar, B., A.V. Katkat (2007). Plant Nutrition. 3rdEd., Nobel Press, Ankara, Turkey.

Khan, A., A.L.I.R. Gurmani, M.Z. Khan, F. Hussain, M.D. Akhtar, and S. Khan (2012). Effect of humic acid on the growth, yield, nutrient composition, photosynthetic pigment and total sugar contents of peas (*Pisumsativum* L.). J. Chem. Soc. Pakistan, tomato. Indian J. Hort., 69 (1):86-90.

Lima, G.S., R.G. Noble, H.R. Gheyi, L.A.A. Smith, G.S. Lawrence and S.S. Silva (2014). Growth and production aspects of irrigated castor beans with saline water and nitrogen fertilizer. J. Agric. Engineer. Amb.,18(6):615-622.

Malan, C. (2015). Review: humic and fulvic acids. A Practical Approach.In Sustainable soil management symposium. Stellenbosch, 5-6 November 2015, Agrilibrium Publisher.

Moussa, L. A A. and S.A. Youssef (2012). An endophytic *Rhizobium* radiobacter strain capable of fixing N_2 in saline – stressed environments. Egypt. J. Agric. Res. 90 (2): 485- 501.

Nardi, S., D.Pizzeghello, A., Muscolo and A. Vianello (2002). Physiological effects of humic substances on higher plants. Soil Biology & Biochemistry, 34: 1527– 1536.

Page, A. I., R. H. Miller and D. R. Keeney (1982). Methods of soil analysis. Part 2. Chemical and Microbiological Properties. Amer. Sci. Agron. Madison. Wisconsin.

Pettit, R.E. (2004). Organic matter, humus, humate, humic acid, fulvic acid and humin their importance in soil fertility and plant health. Available at www. Humate.com/organic matterpetti.pdf

Prazeres, S.S., Lacerda C.F., F.E.L. Barbosa, A.V. Amorim, I.C.S.A. Araujo and L.F. Cavalcante (2015). Growth and gas exchange of cowpea plants under saline irrigation and potassium. Magaz. Agro@e., 9(2):111-118.

Radwan F. I. and M. A. A. Nassar (2011). Response of maize hybrid to biofertilization, soil 1nitrogen application and weed control. Alex. Sci. Exch. J., 32 (4): 409-42.

Rajput, L., A. Imran, F. Mubeen and F. Y. Hafeez (2013). Salt- tolerant PGPR *Planococcus rifietoensis* promotes the growth and yield of wheat (*Triticum aestivum* L.) cultivated in saline soil. Pak. J. Bot., 45(6): 1955-1962.

Rice, R.W., R.A. Gilbert, R.S. Lentini (2006). Nutritional requirements for Florida sugarcane. UF-IFAS Extension SS-AGR-228 Gainesville, FL: University of Florida.

Sallum, M.O. and S. Z. Ali (2011). Effect of agriculture sulfur under flood and drip irrigation system on availability and uptake of phosphours element and growth of cauliflower (B*rassica olerarcea* I.). dally J. Agric. Sci., 3 (2):457-467.

Scherer, H.W., S. Pacyna, K.R. Spoth and M.Schulz (2008). Low levels of ferredoxin, ATP, and leghemoglobin contribute to limited N2 fixation of peas (*Pisum sativum* L.) and alfalfa (*Medicago sativa* L.) under S deficiency conditions. Biol. Fertil. Soils, 44(7): 909-916.

Tarek, M.A.S., N.E. El-Keltawi, M.A. Khan, M. Nan and L.J. Zhao (2013). Plant growth and flowering of cape jasmine (*Gardenia jasminoides* Ellis) in various substrates amended with Sulfur (S). Global J. Pl. Ecophysiology, 3(2): 36-43.

Wei, X., M. Hao, M. Shao and W.J. Gale (2006). Changes in soil properties and the availability of soil micronutrients after 18 years of cropping and fertilization. Soil Till. Res., 91: 120-130.

Wilson, C.S., S.M. Lesch and C.M. Grieve (2000). Growth stage modulates salinity tolerance of New Zealand spinach (*Tetragonia tetragonioides*, Pall.) and red orach (*Atriplex hortensis* L.). Annals of Botany, 85(4): 501-509.

Zaman, B., A. Ali, M. Salim and B.H. Niazi (2002). Role of Sulfur (S) for potassium/sodium ratio in sunflower under saline conditions. Helia,25(37): 69-78.

الملخص العربي

انتاجية الذرة الشامية بإستخدام محسنات التربة والتسميد المعدني والحيوي

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أجريت تجربتان حقليتان بمنطقة النوبارية – البحيرة – مصر أثناء موسمي النمو ٢٠١٧ ، ٢٠١٨ لدراسة تأثير إضافة بعض محسنات التربة (الكبريت وحامض الهيوميك وحامض الفولفيك والكمبوست) والتسميد المعدني و الحيوي لعناصر النتروجين والفوسفور والبوتاسيوم على المحصول ومكوناته والمكونات الكيميائية في هجين الذرة ثلاثي ٣١٠ لتحسين الانتاجية.

ويمكن تلخيص أهم النتائج فيما يلي:

- أدت إضافة حمض الفولفيك والهيوميكوالكمبوست الى زيادة معنوية في أرتفاع النبات وطول الكوزوعدد الحبوب في الصف وعدد الحبوب للكوز ووزن مائة حبة و محصول الحبوب والقش والمحصول البيولوجي (طن/فدان) ونسبة البروتين مقارنة بالكبريت في الموسمين.

- تفوقت المعاملة ٧٥% من الجرعة الموصى بها من التسميد المعدني للعناصر الثلاثة (النتروجين والفوسفور والبوتاسيوم) مع التسميد الحيوي للثلاثة عناصر(NPK) معنوياً تليها المعاملة بـ١٠٠% (الجرعة الموصى بها من العناصر الثلاثة) مقارنة بالتسميد الحيوي منفردا في أرتفاع النبات والمحصول ومكوناته والبروتين في كلا الموسمين.

- أدى التداخل بين إضافة حمض الفولفيك أوالكمبوست أو الهيوميكأسيد مع خليط ٧٥ % من الجرعة الموصى بها من التسميد المعدني للعناصر الثلاثة (النتروجين والفوسفور والبوتاسيوم) مع التسميد الحيوي للثلاثة عناصر(NPK) ادى الى زيادة معنوية في المحصول ومكوناته ومحتوي الحبوب من البروتين للهجين الذرة الشامية ٣١٠.

التوصية

- توصي الدراسة بزراعة هجين الذرة (ثلاثي ٣١٠) مع الأضافة الأرضية ٧٥% من الجرعة الموصى بها من السماد المعدني النتروجيني والفوسفوري والبوتاسي مع أحد محسنات التربة (حامض الفولفيك أو حمض الهيوميك أو الكمبوست) + تلقيح الحبوب بكل من الريزوبكتيرين والفوسفورين والبوتاسيوماج حيث أن هذه التوليفة ذات تأثير معنوي على المحصول ومكوناته ومحتوي الحبوب من البروتين تحت ظروف الزراعة بالنوبارية.