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Effect of biofertilization and organic manuring on growth performance and chemical composition of tomato under saline stress

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ABSTRACT

A greenhouse experiment was carried out using a randomized complete block design (RCBD) with three replicates in the experimental farm station of Fac. Agric. at Moshtohor during 2011 season. This research aims to study the effect of tomato inoculation with salt-tolerant plant growth promoting rhizobacteria (PGPR) strains *Pseudomonas fluorescence* D23, *Bacillus pumilus* D139 and *Azospirillum lipoferum* D178 in combination with humic acid and organic manure (compost) on growth performance and chemical composition of tomato under saline stress. Obtained results revealed that the highest significant of growth characters was observed in case of tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid. Tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid gave the highest significant values of total sugars, total amino acids, titratable acidity, vitamin C , total soluble solids, total and conjugated phenols .Whereas, the highest values of free phenols were observed when tomato inoculated with biostimulant combined with compost at full dose in presence of humic acid. On the other hand, soil amended with biostimulant combined with humic acid gave higher records of chlorophyll A & B, total chlorophyll and carotenoids than soil treated with compost at different doses in combination with biostimulant.

Key words: **Biostimulant, humic acid, *Pseudomonas fluorescence, Bacillus pumilus, Azospirillum lipoferum*, total sugars, vitamin C, amino acids, total and conjugated phenols.**

INTRODUCTION

The agricultural areas affected by salt need amendments such as determination of the most suitable salt tolerant plant species or application of the different substances in order to reduce the effects of salinity **(Aşik *et al.*, 2009).** Salinity negatively affect biological activity by high osmotic strength (low water potential) which can be attributed to the toxic effect on microbial growth, except tolerant halophilic bacteria **(Yildirim *et al.*, 2008)**. Generally, high soil salinity can interfere with the growth and activity of soil microbes hence it indirectly affects the nutrient availability to plants. So, is hypothesized that the use of plant growth promoting microorganisms as inoculants can enhance plant growth under salt stress conditions. Plant growth promoting rhizobacteria (PGPR) are free - living soil borne bacteria that colonize the rhizosphere or symbiotic bacteria **(Nadeem *et al.*, 2006).** In this way, **Sousa *et al.* (2008)** reported that the tolerance for high salinity should be criteria for many microorganisms aiming their adaptation in saline soils and aiming their capacity of colonizing the root system.

Tomato (*Solanum lycopersicum* L.) is a major vegetable crop that has achieved tremendous popularity over the last century. Also, tomato is called the poor apple. It is grown in practically every country of the world in outdoor fields, greenhouses and net-houses. Tomatoes, aside from being tasty, are very healthy as they are a good source of vitamins A and C and antioxidant compounds. The total area of cultivated tomato in Egypt is about 479.4 thousand fed. **(FAO, 2012).**The agricultural benefits of compost application are derived to improve physical properties related to increase organic matter content rather than its value as a fertilizer **(Eid, 2011).** Humic acid, the black gold of agriculture, is a commercial product that contains many elements which improve the soil fertility and increase the availability of nutrient elements. Humic substances might show anti-stress effects under a biotic stress (unfavorable temperature, pH, salinity, etc.) conditions **(Çimrin *et al*., 2010).** The aim of this research is to study the efficiency of six identified salt-tolerant PGPR isolates in presence of soil conditioners (compost and /or humic acid) on tomato growth performance and chemical composition.

MATERIALS AND METHODS

Performance of PGPR isolates for tomato seeds colonization *in vitro*

Petri dishes containing filter paper were autoclaved at 120ºC for15 min. Seeds of tomato varieties namely Super strain B (T1) and Haper (T2) were agitated in 70% ethanol for 5 sec for sterilizing seeds surface. The ethanol was discarded and the seeds were rinsed with sterile water. Then filter paper was moistened about 40% **(Amin *et al*., 2004)**. Ten seeds were put on the filter paper and 1ml of each PGPR strains suspension was added on seeds. The dishes were incubated at 25ºC for six days. Germination rate (%), root length (cm) and colonization intensity (cfu/ml) were estimated, the most priority of tomato for PGPR isolates colonization was chosen for green-house experiment.

Soil and soil mixtures

Soil of the experiment was obtained from El-Sharkia Governorate (Sahl El-Hussinia). The obtained soil was mixed with Agric. gypsum at rate of ½ ton/fed. and course sand at rate of 20 ton/fed., then subjected to mechanical and chemical analyses before using in cultivation **Table 1**. Soil analyses were carried out in Analysis Center and Agricultural Consultancy, Fac. Agric. at Moshtohor according to the method described by **Page *et al.* (1982).**

Humic acid

Humic acid (85%) which contains 56% C, 4.5% H, 31% O and 4.5% N was obtained from Sphinx for International Trade company, Cairo, Egypt was added to soil at a rate of 4 kg/fed.

Organic manure (compost)

The compost was obtained from compost production unit (Faculty of Agriculture, Benha Univ.). The recommended dose (full dose) of compost 10 ton/fed for vegetable crops was added before tomato transplanting. The chemical analyses were given in **Table (2)**.

Table 1.Soil texture and chemical analyses of the experimental soil.

Parameters		Unit	Values	
	Soil texture		Soil before adjustment	Soil after adjustment
Sand		(%)	45.01	50
Silt		(%)	16.32	33
Clay		(%)	38.67	17
Textural class		(%)	Clay	Clayey silty
	Chemical analysis			
EC		dS/m	24.34	13.92
pH			8.30	8.61
Organic matter		(%)	0.62	1.12
Total nitrogen		(%)	0.010	0.114
Soluble cations	Na^+	meq./l	201	57.93
	K^+		1.34	8.27
	Ca_2^+		14.22	35.0

	Mg^{2+}		27.12	38.0
	$CO_3^{=}$		Zero	Zero
Soluble anions	HCO_3^{-}	meq./l	9.93	28.00
	Cl^{-}		186	81.00
	SO_4^{2-}		47.75	30.20

Table 2. Chemical analysis of compost used in this experiment.

Parameters	Unit	Value	Parameters	Unit	Value
pH	-	7.2	**C/N ratio**	-	9.86
EC	ds/m	5.11	**Total-P**	%	1.03
Organic matter	%	33.2	**Total-K**	%	2.11
Organic-C	%	20.7	**Moisture**	%	22
Total-N	%	2.10	**Ash**	%	64.3

Experimental design

Treatments were distributed in a randomized complete block design with three replicates as the following:

1- Control(without any additions.
2- Chemical fertilization.
3- Biostimulant.
4- Compost.
5- Bio. + compost at ½ dose.
6- Bio. + compost at full dose.
7- Bio. + compost at1½ dose.
8- Bio. + HA.
9- Bio. + compost at ½ dose+ HA.
10- Bio. + compost at full dose + HA.
11- Bio. + compost at 1½ dose + HA.

Preparation of biostimulant inocula

The biostimulant inocula were prepared in specific broth media. Cell suspension of *Azospirillum lipoferum D178* contains about 10^6cfu /ml 7 days-old on semi-solid malate medium **(Dobereiner, 1978**), *Bacillus pumilus* D 139 contains about 90 x 10^6 cfu/ml 2 days-old and *Pseudomonas fluorescence* D23 contains about 20 x 10^6cfu/ml 5 days-old on King's medium **(King *et al.*, 1954).**

Cultivation process

Prior to cultivation, tomato transplants were soaked by dipping the root system in a mixture of PGPR inocula (cell suspension of biostimulant) for 60 minutes before transplanting; sucrose solution (40 %) was used as an adhesive agent. The same prepared PGPR inocula were added to grown plants three times throughout the growing season at a rate of 300 ml/pot. The recommended dose of compost was 10 ton/fed for tomato. Whereas, humic acid was added to soil at rate of 4 kg/fed. Compost and humic acid were added at transplanting. A half dose of inorganic nitrogen fertilizer (50 kg N/fed) as ammonium sulphate was supplemented for treatments of biostimulant and biostimulant + humic acid. Also, a full dose of inorganic phosphorus fertilizer (25 kg P_2O_5/fed) as calcium super-phosphate and potassium fertilizer (40 kg K_2O/fed) as potassium sulphate were supplemented for all treatments in three equal doses.

Pots were kept for 120 days in the greenhouse conditions and irrigated with irrigation water.

Determinations

- Colonization ability of PGPR strains for tomato seeds (germination rate (%), root length (cm) and colonization intensity.
- Total, available nitrogen and phosphorus in rhizosphere soil were determined according to the method described by **Page *et al.* (1982).**
- Leaves number/plant, branches number/plant and shoot length.
- Photosynthetic pigments (chlorophyll A & B, total chlorophyll and carotenoids) were spectrophotometrically determined according to **Nornal (1982)** and calculated as mg/g fresh weight of leaves.
- Free, conjugated and total phenols were colorimetrically determined using the "Folin and Ciocalteu" reagent as described by **Snell and Snell (1953)**.Determinations were calculated as catechol in terms of mg phenols/g fresh leaves.
- Reducing, non-reducing and total sugars were colormetrically determined by the picric acid method described by **Thomas and Dutcher (1924)**. Sugar content was determined as mg glucose/g fresh matter calculated from standard curve prepared for glucose.
- The total amino acids were determined according to the method described by **Rosein (1957)**as mg/g fresh weight.
- Vitamin C was assayed in juice of tomato fruits using 2,6-dichlorophenol indophenol dye method (**A.O.A.C., 2005**).
- Titratable acidity was determined in juice of tomato fruits by the titration method with 0.1 sodium hydroxide using phenolphthalein indicator (**A.O.A.C., 2005**).

Statistical analysis

Statistical analysis was carried out according to **Snedecor and Cochran (1989)**. The differences between the means value of various treatments were compared by Duncan's multiple range test **(Duncan's, 1955)**.

RESULTS AND DISCUSSION

Colonization ability of PGPR strains for tomato seeds

This experiment was carried out to examine the ability of the six identified salt-tolerant PGPR strains to colonize two tomato cultivars. Data in **Table 3** indicated that under all treatments T1(Super strain B tomato)showed higher germination rate than T2 (Haper tomato) cultivars. When tomato cultivars were inoculated with two phosphate dissolving bacteria *Pseudomonas fluorescence* D23 and *Bacillus megaterium D159*, the highest germination rate was observed with T1. In addition, whenT1 inoculated with *Pseudomonas fluorescence* D23 the highest root length was obvious being 3.9 cm therefore it increased with 1.5 fold comparing with T2. These results are in agreement with **Davey and O'toole (2000)** who emphasized that the effective colonization of plant roots by PGPR plays an important role in growth promotion, irrespective of the mechanism of action.

Also, by using the nitrogen fixing bacteria namely *Azospirillum lipoferum D178* and *Azospirillum lipoferum D207* the highest germination rate was recorded with T1. Data in **Table 3** also indicated that when T1 inoculated with *Azospirillum lipoferum D178* the highest root length was obvious being 3.8 cm therefore it increased with 2.5 fold comparing with T2.

Table 3.Colonization ability of PGPR strains and their effect on seed germination(after 30 days).

Treatments	Cultivar	Germination rate (%)	Root length (cm)	Colonization intensity cfu/ml (x 10^4)
Control(without any addition)	T1	96	3.2	--
	T2	86	2.0	--
Pseudomonas fluorescence D23	T1	96	3.9	24
	T2	86	2.6	19
Bacillus megaterium D159	T1	91	2.5	21
	T2	80	1.8	27
Paenibacillus alive D135	T1	93	1.8	230
	T2	80	1.3	180
Bacillus pumilus D139	T1	95	2.8	31
	T2	83	2.5	28
Azospirillum lipoferum D178	T1	97	3.8	3.2
	T2	89	1.5	2.1
Azospirillum lipoferum D207	T1	93	2.3	2.8
	T2	86	2.0	3.2

In addition, when tomato cultivars were inoculated with *P. alvie D135*, the lowest germination rate was observed with T2. While, *B. pumilus D139* gave the highest germination rate with T1.This trend of results was in concurrently with **Chebotar *et al.* (2001)** who refer that the colonization of roots by the introduced bacteria is a very important in establishment an effective plant-bacterial interaction. The success of inoculated seeds or seedlings with beneficial bacteria is usually depends on the colonization potential of the introduced strains .Generally, in this experiment T1 (Super strain B tomato) cultivar gave the highest values of colonization intensity when inoculated with *Ps. fluorescence* D23, *B. pumilus D139 and A. lipoferum D178.*. So, these cultivars were used in the following experiments.

Total and available nitrogen and phosphorus in tomato's rhizosphere

Macro-nutrient elements (nitrogen and phosphorus) content were estimated in moderately saline soil inoculated with biostimulant in presence of compost and/or humic acid.

Data in **Table 4** indicated that the lowest records of total and available nitrogen and phosphorus were observed in moderately saline soil without any amendments (control). These results are in agreement with **Page *et al.* (1990)** who reported that in saline soil, the availability of macronutrients is particularly low and plants grown in these soils often show deficiencies of these elements. Obtained data revealed that compost amount affects total nitrogen content in soil, since total nitrogen values were higher in tomato rhizosphere amended with compost at one and half dose combined with biostimulant and humic acid than either half or full dose. Whereas, compost amounts did not affect available nitrogen in tomato rhizosphere. Results indicated that humic acid addition had an essential role in the macronutrients availability. So, soil inoculated with biostimulant in presence of humic acid gave significant higher values of total nitrogen and available nitrogen and phosphorus than soil inoculated with biostimulant only. While, no significant differences in total phosphorus values were observed in these treatments.

Table 4.Total, available nitrogen and phosphorus in tomato's rhizosphere (after 60 days).

Treatments	Nitrogen (%)		Phosphorus (%)	
	Total	Available	Total	Available
Control	0.229^{e}	0.011^{c}	0.151^{e}	0.009^{e}
Chemical fertilization	0.311^{d}	0.013^{bc}	0.157^{c}	0.011^{c}
Biostimulant	0.310^{d}	0.013^{bc}	0.166^{bc}	0.011^{c}
Compost	0.321^{c}	0.019^{b}	0.175^{b}	0.013^{b}
Bio. + compost (½ dose)	0.323^{c}	0.021^{b}	0.178^{b}	0.013^{b}
Bio. + compost (full dose)	0.323^{c}	0.021^{b}	0.178^{b}	0.014^{b}
Bio. + compost (1½ dose)	0.330^{b}	0.021^{b}	0.178^{b}	0.015^{b}
Bio. + HA	0.320^{c}	0.020^{b}	0.166^{bc}	0.018^{ab}
Bio. + compost (½ dose) + HA	0.333^{b}	0.032^{a}	0.182^{ab}	0.018^{ab}
Bio. + compost (full dose) + HA	0.346^{bc}	0.032^{a}	0.182^{ab}	0.021^{a}
Bio. + compost (1½ dose) + HA	0.366^{a}	0.032^{a}	0.188^{a}	0.021^{a}

Control: Without any soil amendments. **HA: Humic acid.**
Biostimulant strains: ***Ps. fluorescence D23, B. pumilus D139 and A. lipoferum D178.***

These results are in harmony with **Meunchang *et al.* (2005)** who reported that the application of compost with plant growth promoting rhizobacteria (A*zotobacter* and *Azospirillum*) increase the available P content by approximately 25% and available N by up to 16%**.**

Growth characteristics of tomato

Data in **Table 5** clearly indicated that the lowest records of tomato growth characteristics i.e. leaves number, branches number and shoot length were observed in plants cultivated in moderately saline soil without any amendments (control). These results are agreed with **Jamil *et al.* (2006)** who reported that root and shoot length of tomato plants is the most important parameter for salinity stress. The salt-tolerant PGPR *Ps. fluorescence* and *Ps. putida* can be used to overcome salinity stress and improving growth and yield of most crops under saline conditions. Also, **Zandonadi *et al.* (2007)** reported that humic acid increased growth and yield of various crops including vegetables.

Concerning the effect of chemical fertilization, data in **Table 5** showed that significant increase in tomato growth characteristics was observed in soil treated with chemical fertilizers than soil treated with biostimulant only. Data also revealed that the highest significant number of leaves was observed in case of tomato inoculation with biostimulant combined with compost at one and half dose in presence of humic acid. This may be due to the beneficial effect of humic on alleviation of soil salinity and improve plant growth.

This result is in agreement with **Cimrin and Yilmaz (2005)** who reported that humic acid is beneficial to shoot and root growth of vegetable crops.It is worthily to mention that the most growth characteristics i.e. branches number and shoot length were not affected with the amount of compost and gave similar records. Similar results were observed by **Alvarez *et al.* (1995)** who reported that the addition of compost to soil cultivated with tomato improved plant growth.

Table 5.Growth characteristics of tomato cultivated in moderately saline soil(after 120 days).

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Treatments	Leaves number/ plant	Branches number/ plant	Shoot length (cm)
Control	12[g]	1[d]	42[f]
Chemical fertilization	30[b]	8[a]	86[a]
Biostimulant	15[ef]	3[cd]	44[ef]
Compost	19[d]	3[cd]	46[ef]
Bio .+ compost (½ dose)	14[fg]	4[bc]	51[de]
Bio .+ compost (full dose)	17[de]	4[bc]	54[cd]
Bio. + compost (1½ dose)	22[c]	4[bc]	50[de]
Bio .+ HA	15[ef]	3[cd]	54[cd]
Bio. + compost (½ dose) + HA	30[b]	3[cd]	58[c]
Bio.+ compost (full dose) + HA	30[b]	6[ab]	57[cd]
Bio. + compost (1½ dose) + HA	40[a]	8[a]	70[b]

Photosynthetic pigments of tomato cultivated in moderately saline soil

Data presented in **Table 6** emphasized that soil salinity leads to decrease chlorophyll content, the lowest values of chlorophyll A, B, total chlorophyll and carotenoids were observed in tomato cultivated in free amendments moderately saline soil(control). This result is agreed with **Alpaslan *et al.* (1996)** who proved that salinity leads to decrease chlorophyll content that is because of increase chlorophylls activity.

Results also indicated that no significant differences were found between chlorophyll A in tomato inoculated with biostimulant combined with compost at different doses. It was clear that tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid gave the highest records of photosynthetic pigments. Similar results were observed by **Jamil *et al.* (2007)** who reported that chlorophyll content was reduced by salt stress. However, PGPRs inoculation elevated the chlorophyll reading values compared to the controls under both salt stress and absence of salt stress. Also, **Chen *et al.*(1994)** who explained several beneficial effect of humic acid such as increasing cell membrane permeability, nutrients uptake and photosynthesis.Data presented in **Table 6** clearly indicated that tomato inoculated with biostimulant only gave higher records of carotenoids being 0.211 mg/g fresh leaves therefore it increased with 1.85 fold comparing with chemical fertilization. While, Chemical fertilization gave significant higher values of chlorophyll A, B and total chlorophyll than the treatments of biostimulant combined with compost at different doses. In addition, when tomato inoculated with biostimulant or compost only, no significant differences were observed in total chlorophyll values. On contrast, soil amended with biostimulant combined with humic acid gave higher records than soil treated with compost at different doses in combination with biostimulant. This result may be attributed to the beneficial effect of humic acid on the activity of microorganisms.

Table 6.Photosynthetic pigments of tomato cultivated in moderately saline soil(after 60 days).

Treatments	Chlorophyll A	Chlorophyll B	Total chlorophyll	Carotenoids
	As mg/g fresh leaves			
Control	0.170[f]	0.075[g]	0.358[f]	0.044[h]
Chemical fertilization	0.789[b]	0.509[c]	1.527[c]	0.114[g]
Biostimulant	0.276[e]	0.194[fg]	0.549[ef]	0.211[f]
Compost	0.285[e]	0.210[ef]	0.577[ef]	0.707[b]
Bio. + compost (½ dose)	0.483[c]	0.321[de]	0.942[de]	0.542[d]
Bio. + compost (full dose)	0.511[c]	0.335[d]	0.989[d]	0.671[c]
Bio. + compost (1½ dose)	0.532[c]	0.355[d]	1.089[d]	0.108[g]
Bio. + HA	0.406[d]	0.750[b]	1.269[cd]	0.265[e]
Bio .+ compost (½ dose) + HA	0.793[b]	1.111[ab]	2.128[b]	0.267[e]
Bio. + compost (full dose) + HA	0.936[ab]	0.140[fg]	2.276[b]	0.239[ef]
Bio. + compost (1½ dose) + HA	1.184[a]	1.198[a]	2.719[a]	1.146[a]

Abbreviations: as those stated for Table (4) Chlor.: chlorophyll Carot.: carotenoids

Phenols and sugars compounds in tomato cultivated in moderately saline soil

It is important to mention that the phenolic compounds accumulate in tomato plants in response to stress, play an important role in salt stress tolerance. Data in **Table 7** showed that the lowest values of total and free phenols were observed in control treatment. Whereas, the lowest records of conjugated phenols were observed in soil amended with humic acid and biostimulant. On the other hand, the highest values of total and conjugated phenols were observed when tomato inoculated with biostimulant in presence of compost at one and half dose combined with humic acid. Whereas, the highest records of free phenols were observed when tomato inoculated with biostimulant combined with compost at full dose in presence of humic acid.

In case of tomato fertilized with chemical fertilization lower values of free phenols being 5.40 mg/g fresh weight therefore it increased with 1.12 fold comparing with either biostimulant or compost each one individually.

Generally, it was clearly that the values of free phenols were higher than the conjugated ones. Concerning the effect of tomato inoculation with biostimulant combined with compost and/or humic acid on sugars, data in **Table 7**showed thatin case of tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid gave the highest significant records of total sugars being 39.13 mg glucose/g fresh weight therefore it increased with 1.3 or 1.2 fold comparing with tomato inoculated with biostimulant or compost each one solely.

Tomato inoculation with biostimulant combined with humic acid gave the lowest values of non-reduced sugars. While, the lowest values of total and reduced sugars were observed in tomato cultivated in free amendments moderately saline soil (control).

It was clearly that the increasing of total sugars was observed with the increasing of compost dose when applied with biostimulant and humic acid. Since, compost at one and half dose gave higher values of total sugars being 39.13 mg/g fresh weight therefore it increased with 1.12 and 1.04 fold comparing with half or full dose, respectively. On the other hand, there were no significant differences were observed in case of tomato inoculated with biostimulant and compost at half or full dose. Similar results were observed by **Selvi *et al.* (1997)** who found that micronutrients application with or without compost and biofertilizer (*Azospirillum lipoferum*) increased total sugars, reducing sugars and non-reducing sugars in tomato.

Table 7. Phenols, sugars and total amino acids compounds in tomato cultivated in moderately saline soil(after 60 days).

Treatments	Phenols mg/g fresh weight			Sugars as mg glucose/g fresh weight			Total amino acids as mg/g fresh weight
	Total	Free	Conjugated	Total	Reduced	Non-reduced	
Control	9.01^{g}	4.56^{g}	4.45^{bc}	27.39^{g}	10.59^{f}	16.80^{e}	1.12^{f}
Chemical fertilization	9.52^{g}	5.40^{f}	4.12^{bcd}	31.30^{ef}	12.11^{de}	19.19^{d}	1.23^{f}
Biostimulant	10.54^{f}	6.06^{ef}	4.48^{bc}	30.19^{f}	13.86^{abc}	16.33^{e}	1.78^{e}
Compost	10.71^{f}	6.07^{ef}	4.64^{bc}	32.42^{de}	14.11^{ab}	18.31^{d}	2.04^{de}
Bio. + compost (½ dose)	11.52^{e}	7.56^{d}	4.00^{bcd}	33.54^{cd}	15.12^{a}	18.42^{d}	2.32^{c}
Bio .+ compost (full dose)	11.73^{e}	7.85^{d}	3.88^{cd}	34.66^{cd}	13.36^{bc}	21.30^{c}	2.34^{c}
Bio. + compost (1½ dose)	14.11^{d}	9.31^{c}	4.80^{b}	35.78^{bc}	12.85^{cd}	22.93^{b}	2.56^{bc}
Bio. + HA	10.20^{f}	6.64^{e}	3.56^{d}	29.63^{f}	14.62^{a}	15.01^{f}	2.00^{e}
Bio. + compost (½ dose) + HA	16.15^{c}	11.91^{b}	4.24^{bcd}	34.66^{cd}	13.86^{abc}	20.80^{c}	2.78^{ab}
Bio. + compost (full dose) + HA	17.34^{b}	13.26^{a}	4.08^{bcd}	37.45^{ab}	11.59^{ef}	25.86^{a}	2.82^{ab}
Bio. + compost (1½ dose) + HA	19.89^{a}	11.65^{b}	8.24^{a}	39.13^{a}	13.86^{abc}	25.27^{a}	2.88^{a}

From data presented in **Table 7** it was clearly that total amino acids were significantly affected with various treatments. In case of tomato inoculation with biostimulant combined with compost at one and half dose in presence of humic acid the highest values of total amino acids were observed being 2.88 mg/g fresh weight therefore it increased with 2.3, 1.6 and 1.4 fold comparing with chemical fertilization, biostimulant only and compost only, respectively. In addition, dual amendments of tomato with biostimulant combined with compost at different doses gave higher values of total amino acids than tomato inoculated with biostimulant or compost each one solely.

Titratable acidity, vitamine C and total soluble solids of tomato fruits

Data presented in **Table 8** indicated that tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid gave the highest records of titratable acidity although therefore no significant differences were observed between this treatment and other treatments. The results clearly indicated that the highest records of vitamin C were observed in tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid followed by tomato treated with chemical fertilization.

Whereas, tomato cultivated in free amendments moderately saline soil gave the lowest records of vitamin C being 29 mg/100 ml juice therefore it decreased with 1.21 and 1.24 fold comparing with tomato inoculated with biostimulant and compost each one solely, respectively.

This result is in agreement with **Ullah *et al.* (1994)** who reported that salinity decreased the content of organic acids (ascorbic and citric) of tomato fruits and thus decreased the fruit quality. Data recorded in **Table 8** revealed that although total soluble solids **(**T.S.S.) was lower in control treatment than tomato inoculated with biostimulant combined with humic acid and soil inoculated with biostimulant only, there were no significant differences were observed between these treatments. On the other hand, tomato inoculated with biostimulant combined with compost at one and half dose in presence of humic acid gave the highest records of T.S.S. being 7.7% therefore it increased with 1.4 and 1.3 fold comparing with biostimulant and compost each one individually, respectively.

Table 8.Titratable acidity, vitamin C and total soluble solids of tomato fruits(after 60 days).

Treatments	Titratable acidity mg/100 ml juice	Vitamin C mg/100 ml juice	Total soluble solids (%)
Control	119.3[a]	29[f]	5.0[b]
Chemical fertilization	123.4[a]	44[ab]	6.5[ab]
Biostimulant	118.7[a]	35[ef]	5.6[b]
Compost	125.7[a]	36[cde]	6.0[ab]
Bio. + compost (½ dose)	121.4[a]	39[abcd]	5.8[b]
Bio .+ compost (full dose)	121.4[a]	38[bcd]	6.1[ab]
Bio. + compost (1½ dose)	126.0[a]	40[abcd]	6.4[ab]
Bio. + HA	120.5[a]	37[bcd]	5.5[b]
Bio .+ compost (½ dose) + HA	124.3[a]	39[abcd]	6.3[ab]
Bio. + compost (full dose) + HA	124.2[a]	43[abc]	6.5[ab]
Bio .+ compost (1½ dose) + HA	127.3[a]	46[a]	7.7[a]

CONCLUSION

In view of the obtained results which showed that the use of the Agric. gypsum was added at a rate of ½ ton/fed.; compost at a rate of 10 ton/fed. and humic acid at a rate of 4 kg/fed. Also, the course sand was added at a rate of 20 ton/fed. obtained to soil texture improvement .All these pre-treatments mentioned above lead to improvement of physical and chemical soil properties for increasing the used PGPR efficiency in improvement tomato growth and chemical composition under similar conditions.

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تأثير التسميد الحيوى والعضوى على مواصفات النمو والتركيب الكيميائى للطماطم تحت ظروف الإجهاد الملحى

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أجريت تجربة تحت ظروف البيوت المحمية فى تصميم قطاعات كاملة العشوائية بمزرعة بحوث كلية الزراعة بمشتهر خلال الموسم 2011 باستخدام ثلاث مكررات بهدف دراسة تأثير تلقيح نباتات الطماطم المزروعة فى تربة ملحية بالبكتريا المشجعة للنمو والمتحملة للملوحة (*Pseudomonas fluorescence D23, Bacillus pumilus D139,Azospirillum lipoferum D178*) مع تدعيم التربة بالكمبوست وحامض الهيوميك على مواصفات نموها وتركيبها الكيميائى. أيضاً ، أوضحت النتائج المتحصل عليها أن تلقيح نباتات الطماطم بالبكتريا المشجعة لنمو النبات مع تدعيم التربة بحامض الهيوميك والكمبوست بمعدل جرعة ونصف أعطى أعلى معدل نمو معنوى للنباتات مقارنة بباقى المعاملات. وقد أخذت نتائج تقدير محتوى النباتات من السكريات الكلية والفينولات الكلية والمرتبطة والأحماض الأمينية الكلية وفيتامين ج والمواد الكلية الذائبة لهذه المعاملة نفس الاتجاه. ولكن وجد أن نفس المعاملات السابقة باختلاف الكمبوست (جرعة كاملة) سجل أعلى قيم من الفينولات الحرة. وقد لوحظ أن تلقيح النباتات بالبكتريا المشجعة للنمو مع تدعيم التربة بحامض الهيوميك أدى إلى ارتفاع قيم كلوروفيل أ، ب والكاروتينات مقارنة بتلقيح النباتات بالبكتريا المشجعة للنمو مع تدعيم التربة بالكمبوست بجرعاته المختلفة.