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Impact of some plant growth promoting rhizobacteria" pgpr" on organically cultivated spinach plants (*spinacia oleracea* l.).

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ABSTRACT

Apot experiment was carried out at the Experimental Farm of Environ. & Bio-Agriculture Dept, Fac. Agric., Al-Azhar Univ., Nasr City, Cairo, Egypt , during the winter season of 2014 to study the impact of some plant growth promoting rhizobacteria (*Bacillus circulans* and *Bacillus polymyxa*), EM and compost tea on growth, chemical composition and yield of organically cultivated spinach plants cv. balady. Results could be summarized as follows: All the treatments of "PGPR" significantly increased the vegetative growth characters, i.e., plant height (cm), number of leaves, leaves area (cm^2) fresh weights (g)/ P, dry weights (g)/P and Leaves weight (g/pot) over the control plants. Results also indicated that the highest significant increase in yield (g/pot) was due to T9 (compost + *B. polymyxa*). Total nitrogen percentages of spinach plants reached the maximum to be 2.21, 2.14 and 2.10 with T3 (Compost + EM), T6 (compost + *B. polymyxa*) and T11 (Compost + EM+ Compost tea + *B. polymyxa*), respectively. While, the highest total percentages of phosphorous and potassium were due to T9 (compost + *B. polymyxa*) and T12 compost + EM + compost tea + *B. polymyxa* + *B. circulans*). The results also, indicated that Treatments 7 (Compost +EM+ Tea) and 12 (Compost + EM+ Compost tea + *B. polymyxa* + *B. circulans*) were significantly in total chlorophyll content a higher content than the control. The treatment 3 (compost + EM) achieved less values for Ca% (0.73%), oxalate (1.24%) and Ca oxalate (1.81%). The treatment (Compost + EM+ Compost tea) gave the highest soil nitrogen content. While, T8 (Compost + EM+ *Bacillus circulans*) recorded the highest soil P content.

Keywords: *Bacillus polymyxa*, *Bacillus circulans*, EM, Compost tea, *Spinacia oleracea L*.

INTRODUCTION

Spinach (*Spinacia oleracea* L.) is one of the most popular leafy vegetable crops grown in Egypt. It is used fresh or canned or frozen product. It is low in calories and a good source of vitamin C, vitamin A and minerals especially iron (*Toledo et al., 2003*). Also It is a good source of vitamin A, C, E, K, B2, B6, B9, folic acid, minerals (Mn, Mg, Fe, K, Ca and Se), and dietary fiber (*Ali et al .,2013*). Spinach is a vegetable with a high biological value, extremely rich in antioxidants especially when fresh, steamed, or quickly boiled (*Cho et al., 2008*).

Many bacterial species, mostly associated with plant rhizosphere have been tested and found to be beneficial for plant growth, yield, and crop quality. They have been called plant growth promoting rhizobacteria "PGPR)". Microbial inoculation by plant growth promoting rhizobacteria (PGPR) are naturally occurring by soil bacteria that aggressively colonize plant roots and benefit plants by providing growth promotion. PGPR are influenced the growth, yield and nutrient uptake by an array of mechanisms. They help in promoting free-living nitrogen-fixing bacteria, increase supply of other nutrients, such as phosphorus, potassium, sulphur, iron and copper, produce plant hormones, and enhance other beneficial bacteria or fungi (Saharan and Nehra, 2011). Various species of bacteria like *Pseudomonas*, *Azospirillum*, *Azotobacter*, *Klebsiella*, *Enterobacter*, *Alcaligenes*, *Arthrobacter*, *Burkholderia*, *Bacillus* and *Serratia* have been reported to enhance the plant growth. (Joseph *et al*., 2007).

Effective microorganisms, is a complex combination of microorganisms that can be found in nature and the food processing industry. This technology was developed in the 1980s, by a Japanese Professor Dr Teruo Higa. These microbes have been cultured in a special combination and developed as a technology for improving soils and plant growing conditions. In 20 years EM technology has developed into a global technology, and is recognized as a powerful and effective tool both in agriculture and horticulture for crop and animal production systems. EM technology is used in over 140 countries around the world. EM or Effective Microorganisms is a consortium culture of different effective microbes commonly occurring in nature. Most important among them are: N_2-fixers,P-solubilizers,photosynthetic microorganisms, lactic acid bacteria, yeasts, plant growth promoting rhizobacteria and various fungi and actinomycetes. In this consortium, each microorganism has its own beneficial in nutrient cycling, plant protection and soil health and fertility enrichment. (Higa, 1996).

Compost tea is by water extraction of compost. The microorganisms present in the compost are multiplied by adding selective nutritive substrata. As the amount of microbes in the extraction increases, the levels of dissolved oxygen decreases and thus air is constantly bubbled through the system to keep the extraction aerobic. After 48 hours this brewing process is complete and the compost tea then consists of nutritive materials (organic compounds, micro and macro elements) and a wide variety of beneficial bacteria, fungi, protozoa and nematodes. Compost tea's efficiency depends on the quality of the compost, the system's extraction efficacy and the ability of the added food to increase the organisms without sacrificing the biodiversity (Ingham, 2005, Scheuerell, 2003, Scheuerell and Mahaffee, 2002).

The aim of this work is to investigate the effects of some plant growth promoting rhizobacteria, i.e., *Bacillus circulans*, *Bacillus polymyxa* and EM (Effective microorganisms solution), as well as compost tea on the growth characters, yield, NPK contents and chlorophyll content of the organically cultivated spanish plants cv. balady.

MATERIALS AND METHODS

A pot experiment was carried out at the Experimental Farm of Environ. & Bio-Agriculture Dept, Fac. Agric., Al-Azhar Univ., Nasr City, Cairo, Egypt, during the winter season of 2014, to evaluate the effect of plant growth promoting rhizobacteria, i.e., *Bacillus circulans*, *Bacillus polymyxa* and EM (Effective microorganisms solution), as well as compost tea on the growth characters, yield, NPK contents and chlorophyll content of the organically cultivated spanish plants cv. balady.

Seeds

Seeds of spinach plants (*Spinacia oleracea* L.) cv. balady were obtained from Horticultural Research Institute, Agric. Res. Center, Giza, Egypt. Seeds were sown at December 30, 2014 in washed sandy soil. Physical and chemical analyses of the experimental soil are present in Table (1) according to Jackson (1976) and Page *et al*. (1982).

Table. 1. Physical and chemical analysis of the experimental soil.

Parameters	Values
Particle size distribution:	
Coarse sand %	44.0
Fine sand %	45.7
Silt %	9.0
Clay %	1.3
Texture class	Sandy
Chemical properties:	
pH 1: 2.5 extract	8.14
EC ($dS.m^{-1}$)	0.31
S. P (%)	26.6
Soluble cations (meq/L)	
Ca^{++}	9.03
Mg^{++}	7.41
Na^{+}	11.3
K^{+}	0.40
Soluble anions (meq/L)	
$CO_3^{=}$	-
HCO_3^{-}	2.0
CL^{-}	18.9
$SO_4^{=}$	7.24
DPTA extractable (mg/kg)	
Micronutrients	
Fe	2.94
Zn	0.96
Mn	0.40
Cu	0.14

Fertilization

Mineral fertilizers (control):

Full recommended dose of NPK was added to the soil (control) . Where nitrogen was added as ammonium sulphate (20.5% N) at a rate of 250 kg/ fed. In two equal doses after 30 and 60 days from sowing, respectively. Phosphorus was applied as super phosphate 15 % P_2O_5 during soil preparation at a rate of 200 kg/ fed. and Potassium was added as potassium sulphate (48% K_2O) at a rate of 75 kg/ fed once at 60 day from sowing.

Compost and compost tea:

For compost preparation, shredded agricultural residues were mixed with farmyard manure and some animal waste (as cow dung) as organic amendments. Composting process carried out by arranging the plant residues materials with the different amendments at equal portion in successive layers along with maintaining moisture content at 60% during the composting process, moistening was considered satisfactory when a handful of composted materials would wet the hand but not drip. The produced mature compost was supplied with some natural additives (rock phosphate at a rate of 1kg, feldspar at a rate of 1kg, dolomite at a rate of 250 g, agricultural sulfur at a rate of 250 g and mushrooms waste at a rate of 300 g), and then used to prepare the aqueous extract (compost tea) as described by Badawi *et al*. (2014) through soaking of the mature compost in tap water for 7 days at the ratio of 5:1 (water: compost v/w). After this period the mixture was sieved to obtain the used compost tea. Some properties of compost and compost tea are shown in Tables (2&3), respectively.

Table. 2.Some physical, chemical and microbiological characteristics of compost

Property	Value
Color	Dark brown
Bulk density (kg/m^3)	546.0
Water holding capacity (%)	203.4
pH (1:10 extract)	7.12
EC (dS/m)	3.67
Organic carbon (%)	26.10
Organic matter (%)	44.89
Total-N (%)	1.61
C/N ratio	16.21
Total-Phosphorus (%)	1.16
Total-Potassium (%)	1.73
Total soluble-N ($mg\ kg^{-1}$)	689.5
Available-P ($mg\ kg^{-1}$)	276.4
Available-K ($mg\ kg^{-1}$)	761.9
DTPA*-extractable ($mg\ kg^{-1}$):	
Fe	199.8
Mn	44.2
Zn	55.1
Cu	6.5
CEC (c mol/kg)	123.6
E_4/E_6 ratio	3.91
Total count of bacteria (cfu/g)	3.1×10^7
Total count of fungi (cfu/g)	1.2×10^5
Total count of actinomycetes (cfu/g)	1.3×10^6
Dehydrogenase activity (mg TPF**/100 g)	188.9
Germination test of cress seeds*** (%)	89.0

*** Di-ethylene tri-amine penta acetic acid**
****Trichloro-Phenyl-Formazan**
*****Cress seeds incubated for 48 hr.**

Plant growth promoting rhizobacteria

Been using three sources of plant growth promoting rhizobacteria as follows:

Microbial inoculation

Bacillus circulans and *Bacillus polymyxa* were obtained from Microbiol. Resour. Center (MIRCEN), Fac. Agric., Ain Shams Univ., Qalubia, Egypt. The PGPR cultures containing 10^6 cfu/ ml were used at rate of 100 ml. for each applied bacterial strain which was used as single treatment, as well as their mixture was prepared using 50 ml from each bacterial strain which were thoroughly mixed together just before inoculation for combined treatments. Bacterial cultures were coated onto spinach seeds using Arabic gum (40%) as an adhesive agent and then dried in shade for one hour before sowing.

Table 3. The main chemical and microbiological traits of the bio-enriched compost tea

Trait	Value
pH	6.90
E.C. (dS m^{-1} at 25°C)	2.83
Organic-C (%)	5.92
Total- N (%)	0.028
NH^+_4 -N (ppm)	81.6
NO^-_3 -N (ppm)	14.0
Total soluble-N (ppm)	95.6
Available-P (ppm)	41.2
Available-K (ppm)	128.7
Extractable - Fe (ppm)	16.4
~ - Mn (ppm)	3.5
~ - Zn (ppm)	6.8
~ - Cu (ppm)	1.5
E_4/E_6 ratio	3.91
Total count of bacteria (cfu ml^{-1})	8.1 x 10^7
Total count of fungi (cfu/ml)	7.3 x 10^5
Total count of actinomycetes (cfu ml^{-1})	1.3 x 10^6
Germination test of cress seeds (%)	91.0

Effective Microorganisms (EM)

EM obtained from the Egyptian Ministry of Agriculture, Dokki, Giza. The rate of addition of compost Tea was 15 L/fed (0.4 ml / pot), along with each irrigation.

Compost Tea

Compost Tea was added at the rate of 75 L/fed (0.4 ml / pot), along with each irrigation.

Experimental design:

Pot experiment was carried out in the growing winter season of 2014..The experimental treatments were arranged in a complete randomized pot design (Each experimental plastic pot diameter was 30 cm and field weight 18 kg soil) with three replicates as the following:

T1 The recommended dose of chemical fertilizer
T2 Compost
T3 Compost + EM
T4 Compost + Tea Compost
T5- Compost + *Bacillus circulans*
T6- Compost + *Bacillus. polymyxa*
T7 - Compost + EM+ Tea Compost
T8 - Compost + EM+ *B. circulans*
T9 - Compost + EM+ *B. polymyxa*
T10- Compost + EM+ Tea Compost+ *B. circulans*
T11- Compost + EM+ Tea Compost+ B. *polymyxa*
T12- Compost + EM+ Tea Compost+ *Bacillus circulans+ B. polymyxa*

Measurements:

The studied parameters were: plant height (cm), number of leaves, leaves area (cm^2) fresh weights g/pot, dry weights g/pot, leaves weight g/pot and yield (g/pot). Total chlorophyll (mg/fresh leaves) was determined according to (Anon, 1979). Nitrogen, phosphorus and potassium percentage (N, P, and K %) in spinach plants were determined according to (Jackson 1976). Calcium, oxalate and calcium oxalate percentage (Ca, oxalate and Ca oxalate %) were determined according to (Jackson, 1976) and total nitrogen percentage in soil were determined according to (Jackson, 1976) and total phosphorus, total potassium were determined according to (Page et al., 1982).

Statistical analysis:

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the randomized complete block design (RCBD) as published by Gomez and Gomez (1984) by using means of "MSTAT-C" computer software package. Means of treatments were compared using Duncan's multiple range tests at 5 % level of probability as described by Duncan (1955).

RESULTS

Data in Table (4) show the effect of some plant growth promoting rhizobacteria (*Bacillus circulans* and *Bacillus polymyxa*), EM and compost tea on the some vegetative growth of spinach (*Spinacea oleracea* Linn). All the treatments of "PGPR",EM, compost and compost Tea significantly increased the vegetative growth characters (plant height(cm), number of leaves, leaves area (cm^2) fresh weights (g/p), dry weights (g/p) and Leaves weight (g/p) over the control plants. The treatment T2 was the best treatment in increasing the plant height, fresh weights and dry weight. The number of leaves and the leaves area increased with T3 (Compost +EM) and T6 (Compost + *B. polymyxa*), respectively. The leaves weight significantly increased with T7 (compost +EM). On the other hand, the results indicated that a highly significant increase in yield (g/pot) was found with Treatments 5 and 6 (compost + *B. circulans* and compost + *B. polymyxa*).

The content of total nitrogen of spinach plants, data reported in Table (5) clearly showed that, the percent of total nitrogen reached the maximum level being 2.21, 2.14 and 2.10 with T3, T 6 and T11, respectively. Due to total percentage phosphorous of spinach plants, data in Table (5) showed that treatmentT9 (compos+ *B. polymyxa*) recorded the highest percentage of 1.47%. While for the total percentage potassium, data in Table (4) showed that treatments T12 (compost+ EM+ Tea compost +B. polymyxa+ B. circulans) recorded the highest one of 0.52. The results in Table (5) also indicated that the treatments of T7 (Compost +EM+ Tea) and T12 (Compost+ EM+ Tea+ *B. polymyxa* + *B. circulans*) gave significantly higher total chlorophyll content than the control treatment.

Table 4. Effect of using some plant growth promoting rhizobacteria "PGPR" on the vegetative growth of spinach plant during the winter season of 2014

Characters / Treatments	Plant height (cm)	No. of leaves	Leaves area (cm2)	Fresh weight (g/pot)	Dry weight (g/pot)	Leaves weight (g/pot)	Yield (g/pot)
Control NPK	33.67^{def}	23.67^{f}	17.78^{c}	4.100^{b}	0.5333^{de}	1.433^{b}	20.00^{b}
Control NPK (T_1)	48.00^{a}	39.33^{c}	38.73^{a}	7.233^{ab}	1.390^{a}	3.633^{b}	31.67^{ab}
Compost (T_2)	39.33^{bcd}	50.33^{a}	23.43^{c}	5.467^{ab}	0.9167^{bcd}	2.733^{b}	31.60^{ab}
Compost +EM (T_3)	42.00^{b}	24.67^{f}	35.15^{ab}	6.900^{ab}	1.090^{ab}	3.100^{b}	22.40^{ab}
Compost + Compost Tea (T_4)	35.67^{cde}	30.00^{e}	25.36^{c}	5.300^{ab}	0.6500^{cde}	2.467^{b}	33.23^{a}
Compost + *B.circulans* (T_5)	38.00^{bcde}	46.67^{ab}	41.70^{a}	6.333^{ab}	1.117^{ab}	3.833^{b}	33.47^{a}
Compost + *B. polymyxa* (T_6)	40.00^{bc}	45.67^{ab}	26.76^{bc}	5.017^{b}	0.9467^{bcd}	10.87^{a}	22.07^{ab}
Compost +EM+ Tea (T_7	32.00^{ef}	20.67^{f}	18.30^{c}	3.467^{b}	0.4967^{e}	1.367^{b}	21.57^{ab}
Compost+EM+ B. circulans (T_8)	29.33^{f}	24.33^{f}	18.12^{c}	2.933^{b}	0.4133^{e}	1.300^{b}	21.83^{ab}
Compost+EM+ *B. polymyxa* (T_9)	34.33^{dcef}	35.00^{d}	27.89^{bc}	5.133^{b}	0.7500^{bcde}	2.500^{b}	26.40^{ab}
Compost +EM+ Tea+ *B. circulans* (T_{10})	33.67^{def}	33.33^{de}	25.28^{c}	4.767^{b}	0.6267^{cde}	2.067^{b}	25.67^{ab}
Compost +EM+ Tea+ *B.polymyxa* ($T1_1$)	38.00^{bcde}	23.67^{f}	35.79^{ab}	9.633^{a}	1.003^{abc}	4.067^{b}	31.60^{ab}

Table 5. Effect of using some plant growth promoting rhizobacteria "PGPR" on the chemical composition of spinach plant during the winter season of 2014

Characters / treatments	N %	P %	K %	Total Chlorophyll content
Control NPK	1.030^{cd}	0.4133^{e}	0.3033^{b}	26.57^{bcd}
Compost	1.127^{cd}	0.8800^{cd}	0.3700^{ab}	28.40^{bcd}
Compost +EM	2.217^{a}	1.040^{bcd}	0.4000^{ab}	30.07^{abc}
Compost + Compost Tea	1.930^{ab}	0.8967^{cd}	0.4000^{ab}	26.70^{bcd}
Compost + *B.circulans*	0.6967^{d}	1.057^{bcd}	0.4100^{ab}	26.37^{bcd}
Compost + *B. polymyxa*	2.147^{ab}	0.4900^{cd}	0.3800^{ab}	30.17^{ab}
Compost +EM+ Tea	0.6567^{d}	0.9233^{cd}	0.3967^{ab}	33.23^{a}
Compost+EM+ B. circulans	1.013^{cd}	1.167^{abc}	0.4000^{ab}	24.90^{d}
Compost+EM+ *B. polymyxa*	2.080^{ab}	1.473^{a}	0.4100^{ab}	27.60^{bcd}
Compost +EM+ Tea+ *B. circulans*	1.997^{ab}	1.357^{ab}	0.3500^{ab}	26.13^{cd}
Compost +EM+ Tea+ *B.polymyxa*	2.107^{ab}	1.093^{bcd}	0.3700^{ab}	25.30^{d}
Compost+EM+ Tea+*B. polymyxa* + *B. circulans*	1.487^{bc}	0.7700^{d}	5267^{a}	32.40^{a}

Data in Table (6) showed that the content of Ca%, oxalate% and Ca oxalate % in leaves decreased as a result of using all the tested treatments compared to the control treatment. The treatment 3 (compost +EM) achieved less values of 0.7333, 1.247 and 1.813% for each of Ca, oxalate and Ca oxalate, respectively.

Table 6. Effect of using some plant growth promoting rhizobacteria "PGPR" on the content of leaves Ca, oxalate and Ca oxalate percentages

Characters / Treatments	Ca%	Oxalate%	Ca oxalate %
Control NPK	2.080^{a}	3.110^{a}	4.857^{a}
Compost	0.8133^{b}	1.790^{bc}	2.600^{b}
Compost +EM	0.7333^{b}	1.247^{d}	1.813^{c}
Compost + Compost Tea	0.8500^{b}	2.093^{bc}	3.050^{b}
Compost + *B.circulans*	0.8333^{b}	1.837^{bc}	2.667^{b}
Compost + *B. polymyxa*	0.9133^{b}	2.010^{bc}	2.923^{b}
Compost +EM+ Tea	0.8033^{b}	1.763^{bc}	2.657^{b}
Compost+EM+ *B. circulans*	0.7533^{b}	1.653^{cd}	2.407^{b}
Compost+EM+ *B. polymyxa*	0.8700^{b}	1.913^{bc}	2.780 ^{b}
Compost +EM+ Tea+ *B. circulans*	1.033^{b}	2.277^{b}	2.650 ^{b}
Compost +EM+ Tea+ *B.polymyxa*	0.8800^{b}	1.933^{bc}	2.810^{b}
Compost+EM+ Tea+*B. polymyxa* + *B. circulans.*	1.057^{b}	1.987^{bc}	2.703^{b}

Concerning the total N, P and K contents in soil, the results in Table (7) indicated that the treatments of T7, T9 and T11 gave the highest nitrogen soil content. While, the treatments of T3, T4, T6, T7, T8 and T12 gave the highest soil percentages phosphorus content. Also, the treatments of T4 and T7 were gave the highest potassium soil content.

Table 7. Effect of using some plant growth promoting rhizobacteria "PGPR" on the N,P and K content in soil

Characters / treatments	N %	P %	K %
Control NPK	36.97^{e}	5.500^{ab}	129.5^{b}
Compost	61.11^{bcd}	5.480^{ab}	160.8 ^{ab}
Compost +EM	82.99^{a}	6.603^{a}	153.9^{ab}
Compost + Compost Tea	71.56 ^{abc}	6.780^{a}	179.7^{a}
Compost + *B.circulans*	77.85^{ab}	5.683^{ab}	155.4^{ab}
Compost + *B. polymyxa*	78.42^{ab}	7.073^{a}	165.2^{ab}
Compost +EM+ Tea	85.99^{a}	6.203^{a}	180.1^{a}
Compost+EM+ *B. circulans*	59.03^{cd}	6.470^{a}	159.9^{ab}
Compost+EM+ *B. polymyxa*	83.55^{a}	4.350^{b}	166.3^{ab}
Compost +EM+ Tea+ *B. circulans*	52.99^{de}	5.583^{ab}	162.2 ^{ab}
Compost +EM+ Tea+ *B.polymyx*	82.46^{a}	5.833^{ab}	151.0^{ab}
Compost+EM+ Tea+*B. polymyx+ B. circulans*	76.50^{abc}	6.353^{a}	154.0^{ab}

DISCUSSION

The positive effect of the application using some plant growth promoting rhizobacteria (*Bacillus circulans and Bacillus polymyxa*), EM and compost tea on the vegetative growth , chemical composition and yield of spinach plants and the content of the soil major elements may be due to the Plant growth promoting rhizobacteria that inhabiting around/on the root surface and are directly or indirectly involved in promoting plant growth and development ***via*** production and secretion of various regulatory chemicals in the vicinity of rhizosphere. Generally, plant growth promoting rhizobacteria facilitate the plant growth directly by either assisting in resource acquisition (nitrogen, phosphorus and essential minerals) or modulating plant hormone levels, or indirectly by decreasing the inhibitory effects of various pathogens on plant growth and development in the forms of biocontrol agents. Various studies have documented the increased health and productivity of different plant species by the application of plant growth promoting rhizobacteria under both normal and stressed conditions. The plant-beneficial rhizobacteria may decrease the global dependence on hazardous agricultural chemicals which, destabilize the agro-ecosystems.The obtained results were in agreement with that obtained by Abd El-AbdEl-Fattah *et al.* (2003), Alderfasi *et al.* (2010) and Ali *et al.* (2013). Also as a result of microbial composition unique to EM, which consist of N_2-fixers, P-solubilizers, photosynthetic microorganisms, lactic acid bacteria, yeasts, plant growth promoting rhizobacteria and various fungi and actiKNnomycetes. In this consortium, each microorganism has its own beneficial role in nutrient cycling, plant protection and soil health and fertility enrichment (Higa, 1996). On the other hand, the compost tea works on enhanced disease suppression or resistance towards diseases, to promote crop health , Provision of water soluble, available nutrients around the plant roots , Increased soil microorganism populations and diversity to improve soil structure, and rooting depth and plant growth (Scheuerell, 2000, Kelley, 2004 and Grobe, 2003).

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تأثير استخدام بعض البكتريا الجذرية المشجعة لنمو النبات (PGPR) علي نبات السبانخ المزروع عضويا . (*Spinacia oleracea* L.)

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أجريت تجربة أصص بمزرعة قسم البيئة والزراعة الحيوية كلية الزراعة جامعة الأزهر- القاهرة خلال الموسم الشتوي ٢٠١٤ لدراسة تأثير استخدام بعض البكتريا الجذرية المشجعة لنمو النبات (PGPR) علي نبات السبانخ (*Spinacia oleracea* L) المزروع عضويا، وكانت أهم النتائج كما يلي :أعطت كل المعاملات باستخدام البكتريا الجذرية المشجعة لنمو النبات (PGPR) إلي زيادة كل الصفات الخضرية لنبات السبانخ (طول النبات - عدد الاوراق - مساحة الاوراق - الوزن الطازج والجاف للنبات).أدت المعاملة رقم ٦ (Compost + *B. polymyxa*) أعلي قيمة للمحصول ٣٣.٤٧ جرام / لكل أصيص.أدت المعاملات ٣ (Compost +EM) و ٦ (Compost + B. polymyxa) و ١١ (Compost + EM+ Tea+ *B.polymyxa*) إلي زيادة محتوي أوراق السبانخ من النيتروجين ، في حين أعطت المعاملة رقم ٩ (Compost+EM+ *B. polymyxa*) أفضل قيمة للفوسفور حيث سجلت ١.٤٧٣% بينما سجلت المعاملة رقم ٧ (Compost +EM+ Tea) أعلي قيمة للبوتاسيوم بأوراق السبانخ ٣٣.٢٣%.سجلت المعاملة رقم ٣ Compost+EM أدني قيمة للكالسيوم والنسبة المئوية للأكسالات والنسبة المئوية لأكسالات الكالسيوم حيث كانت ٠.٧٣% ، ١.٢٤ %، ١.٨١.% علي التوالي. سجلت المعاملة رقم ٧ (Compost +EM+ Tea) أعلي قيمة لمحتوي التربة من النيتروجين والبوتاسيوم كنسبة مئوية حيث كانت ٨٥.٩٩% ، ١٨٠.١% علي التوالي، في حين سجلت المعاملة رقم ٨ (Compost+EM+ *B. circulans*) أفضل قيمة للفوسفور بالتربة حيث أعطت ٦.٤٧%. وبصفة عامة توصي الدراسة بأهمية استخدام البكتريا الجذرية المشجعة لنمو النبات مع نبات السبانخ وخاصة المزروع تحت ظروف الزراعة العضوية.