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Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on sweet basil plant

[1]Hanaa A. Abo-Kora and [2]Maie Mohsen M. A.

[1]Soils, Water and Environ. Res. Inst., Agric., Res. Center, Giza, Egypt
[2]Medicinal & Aromatic plants. Res. Dept., Hort. Res. Inst., A. R. C., Dokky, Giza, Egypt.

Abstract: This study was carried out during the two successive growing seasons of 2012./ 2013 and 2013/2014 at the farm of Soils, Water and Environ. Res. Inst., Agric., Res. Center in Sahal El-Tina (North of Egypt), to investigate effects of two plant growth promoting rhizobacteris (PGPR) after encapsulating on growth, essential oil %, essential oil yield and its components and chemical compotition of basil Ocimum basilicum,cv. "Grand Vert" at three levels of compost (0,20,40 m^3/fed) under soil salinity.

Gradual and significant increases in plant height, number of branches, fresh & dry weights per plant, essential oil percentage, and essential oil yield per plant were recorded with increasing the with compost at 20 m^3/fed. Also, 40 m^3/fed. Compost produced the highest percentages of main components of the essential oil (Linalool, Camphor and Anethol)which resulted under the effect of 20 m^3/fed. While the highest percentages of Cineol resulted under the effect of 40 m^3/fed compost. Also, compost treatments increased total chlorophyll (a+b),total carbohydrates % and nutrient contents of P and K while reduced the Na., proline and antioxidant activity content compared to the control.

As for two plant growth promoting rhizobacteris (PGPR) Paenibacillus polymyxa and Azospirillum lipoferum enhanced the above mentioned traits of growth and essential oil. The highest percentages of Linalool, Camphor and Anethol were recorded in essential oil extracted from plants treated with T6 (Combination of microorganisms encapsulated with sodium alginate), while the highest percentages of Cineol resulted under the effect of T7(Combination of microorganisms carried on free suspension) comparing to control. On the other hand, the lowest percentages of these components resulted under the treatment with T4(Azosprillum lipoferum carried on free suspensio). In addition that,T6(Combination of microorganisms encapsulated with sodium alginate) increased total chlorophyll (a+b), total carbohydrates % and nutrient contents of P and K but decreased Na content, proline and antioxidant activity content compared to the control.

Interaction treatments of T6 (Combination of microorganisms encapsulated with sodium alginate) with20 m^3/fed compost resulted in significant increases in the above mentioned traits (plant growth, essential oil determinations). The combined between 20 m^3/fed compost and PGPR inoculation T6(Combination of microorganisms encapsulated with sodium alginate) gave the highest values of the Linalool and Camphor. While the combined between 40 m^3/fed compost and PGPR inoculation T6(Combination of microorganisms encapsulated with sodium alginate) showed the highest values of the Anethol content. Also, the highest values of the Cineol was obtained in the plants which treated by Treatment T7(Combination of microorganisms carried on free suspension) amended with 20 m^3/fed compost. In addition, the highest total chlorophyll (a+b),total carbohydrates and Nutrient contents (P and K) were recorded in herbs of treated plants with 20 m^3/fed compost and PGPR inoculation T6(Combination of microorganisms encapsulated with sodium alginate). On the opposite, the all tested treatments gave the lowest proline, and antioxidant activity and Na content compared to the control.

Key words : *Ocimum basilicum*, "Grand Vert", capsule, *Azosprillum lipoferum*, *Paenibacillus polymyxa*. compost, chemical composition and essential oil components.

Introduction

Sweet basil (*Osmium basilicum)* belongs to the family lamiaceae and is one of the most important species of the *ocimum* genus being a source of essential oil[1]. Sweet basil has been used for thousands of years as a culinary and medicinal herb. It acts principally on the digestive and nervous systems, easing flatulence, stomach cramps, colic and indigestion. The leaves and flowering tops are antispasmodic, aromatic, carminative, digestive, galactogogue, stomachic and tonic[2]**.** They are taken internally in the treatment of feverish illnesses (especially colds and influenza), poor digestion, nausea, abdominal cramps, gastro-enteritis, migraine, insomnia, depression and exhaustion. Externally, they are used to treat acne, loss of smell, insect stings, snake bites and skin infections[3]. The essential oil is used in aromatherapy. It used for kidney disease, gum ulcers, earache, rheumatoid arthritis, anorexia, itching, menstrual disorders, and malaria[4]**.**

Salinity is one of the major factors reducing plant growth in the most parts of the world[5]. Salinity stress also decrease photosynthetic capacity due to the osmotic stress and partial closure of stomata**.** Plants can suffer from membrane destabilization and general nutrient imbalance[6]. Salt stressed plants accumulate various molecules found in organic matter such as Proline, glucose, glycin betaine etc, in the cell membrane for osmoregulation to occur thereby protecting enzyme activity[7].

Encapsulation of microbial cells for soil application provides a range of a advantages such as ease of application to the soil, reduced off – site drifting, and protection of cells from environmental stress. In addition, encapsulated preparation possess high cell loading capacity high retention of cell viability increased rate of production of microbial products and also act as a reservoir that releases cells at a slow and constant rate, microbes contained within polymers provide a convenient inoculums for numerous industrial, environmental, and agricultural application[8].

The role of biofertilizers for enhancing the producing of soil by fixing atmospheric nitrogen, by solubilising soil phosphorus, or by stimulating plant growth through synthesis of growth promoting substance has special importance inorganic forming. Plant growth promoting rhizobacteris (PGPR) are a group of bacteria that can actively colonize plant roots and increase plant growth. These PGPR can prevent the deleterious effects of phytopathogenic organisms and stresses from the environment[9]**.** PGPR produce plant growth promoting compounds including phytohormones; axons, cytokines and gibberellins, as well as siderophores and antibacterial peptides that inhibit pathogenic strains .

Organic farming as compost is one of the practices to make the production system more sustainable without adverse effects on the natural resources and the environment[10]**.** It not only maintains soil fertility but also conserves soil moisture[11]**.** Organic fertilizers increases the availability and absorption of the essential nutrient elements, such as Fe_2^+, Mg_2^+ and NH_4^+ cat ions, which are necessary for enzyme activation and chloroplast and chlorophyll formation. Application of organic fertilizers or their extracts also have positive effects on plant growth, dry matter yield and root development[10]**.**

Considering that salinity is a major problem in the Egypt, the objective of the current study was to determine the relations between the treatment by free or alginate-encapsulated formulation of Nitrogen fixers bacteria in single or dual with different levels of compost on sweet basil (*Ocimum basilicum* L.) plants under salinity stress.

Materials and Methods

Bacterial isolates

Ten bacteria were isolated from the rhizosphere soil of basil plant grown on saline soil from Sahl El-Tina. These bacteria were grown on Watanabe medium[12] at 28°C for 72 hours.

Bacteria Morphological and Biochemical Characterization

Morphological characteristics of all isolates viz, colony morphology (color, shape, surface) were studied. All of isolates were tested to gram stain, Indole Acetic Acid (IAA) Production, a cording to[13],

Gibberellins acid (GA), according to[14] and Nitrogenase activity according to[15]. The most active two isolates were identified through 16S r DNA. The genomic DNA of PGPR was amplified by the method as described by[16]**.** Sequencing was done using Big Dye terminator cycle sequencing kit v.3.1 (Applied Bio Systems, USA) and the sequencing products were resolved on sequencer ABI 3730 x l DNA Analyzer (Applied Bio Systems, USA) at the GATC biotech in Germany. The results were compared by using BLAST algorithm (www.ncbi.nlm.nih.gov/BLAST).The isolates were identified as *Azosprillum lipoferum* (AB681746) and *Paenibacillus polymyxa* A549 (J F496380).

Encapsulation of isolates

For encapsulation, both two bacterial isolated were grown in 100 ml of nutrient medium for 72 h at 30°C. The cells were harvested at log phase (10^8 c f u $^{-1}$ m l) by centrifugation (4°C at 5000g). Cell pellets were capsulated in both two strains according to[17]**.** To test the viability of beads, ten beads were solubilized for cell counts in 0.2 M phosphate buffered saline (PBS) pH 7.0 after 7 , 30 ,90 , 180 days under gentles shaking for 30 min . Serial dilutions were carried out on specific medium of each used inoculums according to the method described by[18]**.**

Shape of the capsules with alginate

Experimental design

Field experiments were conducted in clay soil at Sahl El-Tina Agric. Res. Station, (North of Egypt) to study the effect of free or alginate-encapsulated formulation of Nitrogen fixers bacteria in single or dual and compost on saline soil. Some physical and chemical characteristics of the studied soil and irrigation water are presented in Table (A&B) respectively, according to[19]**.**

Table (A): The main physical and chemical properties analyses of experimental soil

Course sand (%)	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Soil Texture**	**OM (%)**	**$CaCO_3$ (%)**
12.85	71.5	13.8	14.7	Loamy sand	0.48	7.9

pH (1:2.5)	EC*(dSm^{-1})	Cations (meq/l)				Anions (meq/l)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO^{-}_3	Cl^{-}	SO^{--}_4
8.45	10.86	7.85	12.63	44.00	1.40	20.0	33.0	29.2

Table (B): Physical and Chemical analysis of irrigation water

pH (1:2.5)	**EC(dSm^{-1})**	**Sodium Adsorption Ratio(SAR)**
8.25	**2.21**	**4.55**

Macro-micronutrients (mg/L)						
NO_3 -N	NH_4 -N	P	K	Fe	Mn	Zn
20.04	10.52	2.88	6.83	1.90	2.20	0.77

The experiments were carried out during two successive seasons 2013 and 2014, on sweet basil (*Ocimum basilicum* L.) cv. "Grand Vert". Sweet basil seeds that used in this study were obtained from Medicinal and Aromatic Plants Research Department, Dokki, Giza. They were sown on 15th January in a peat moss medium in the nursery beds. Two months after sowing the seeds (on 15th March, 2013 and 2014 in the first and second seasons, respectively), when the seedlings were 12-17cm in height, with 6-8 leaves, were transplanted in plots 2.0× 3 m with 3 rows/ plot in hills at 30 cm apart within the same row. Each plot contained 21 plants. The experimental design was a split plot design with three replicates. Compost at 0, 20 and 40 m^3/fed. and two types in two forms of bacteria. So, the experiment implicated 21 interaction treatments.

The compost fertilizer (COM) was obtained from the Egyptian company for Waste Recycling was added in one dose; at rates were 0, 20 and 40 m3/ fed. Which was incorporated into the soil to a depth of 15-20 cm, two weeks before transplanting date (on 1st March 2013 and 2014, in the first and second seasons, respectively). The physical and chemical characteristics of the Compost fertilizer are presented in Table (C) described by[20].

Table (C): Physical and chemical characteristics of the used Compost fertilizer

The character	1st season	2ed season
Weight of 1 m^3 (kg)	375	400
Moisture content (%)	25	30
Organic Matter (%)	55.62	45.21
Organic Carbon (%)	35.88	33.26
Total N (%)	1.8	2.08
C:N ratio	19.7:1	17.2:1
Total P (%)	1.47	1.24
Total K (%)	1.26	1.12
Fe (ppm)	1080	1051
Mn (ppm)	114	110
Zn (ppm)	54.9	38.3
EC	3.2	4.4
pH	6.7	7.2

The six form of bacterial strain were used as main plots and the compost was as sub plots the treatments of bacteria as follows:

T1. Control without inoculation
T2. *Azosprillum lipoferum* encapsulated with sodium alginate.
T3. *Paenibacillus polymyxa* encapsulated with sodium alginate.
T4. *Azosprillum lipoferum* carried on free suspension (10^8 cells ml^{-1}).
T5. *Paenibacillus polymyxa* carried on free suspension (10^8 cells ml^{-1}).
T6. Combination of microorganisms encapsulated with sodium alginate.
T7. Combination of microorganisms carried on free suspension.

Inoculation treatments

Seedlings of basil were treated with two forms of bacteria. Suspension form was carried out five times with bacteria; the first time was used as soaking for seedlings for 30 minute before planting. The other times were sprayed (twice for every cut), in the first cut, spraying was conducted at 15th April and 18th May while in the second cut it was at 10th June and 10th July in the two seasons, respectively. The other form of bacteria is capsulated bead, for each seedling need 100 mg beads[18].

Recorded Data:

Each season, two cuts were taken from the plants on 15th June and10th August (2013and 2014). The plants were harvested by cutting the vegetative parts 10-15 cm above the soil surface. The following data were recorded for each cut:

Plant growth and herb yield:

Vegetative growth records were implicated plant height (cm), number of branches/plant, fresh and dry weights (g)/plant.

Essential oil determinations:

Essential oil was extracted from fresh herb samples of each treatment by distillation according to the method of[21], and oil percentages were recorded. Then, oil yield per plant was calculated. Also, Samples of the extracted essential oil of the second cut of the first season 2013 were subjected to gas-liquid chromatographically (GLC) analysis as described by[22] to determine percentages of the main components of the volatile oil.

Antioxidant Enzymes*:*

Antioxidant enzymes were assayed as follows: Catalase (CAT) by measuring the decrease in absorbance due to disappearance of H_2O_2 at 240 nm according to[23]**,** peroxidase (POD) by spectrophotometer according to[24]**.** Enzymes activities were expressed as units / gram fresh weight.

Leaves chemical analysis:

Determination of total chlorophyll, carbohydrates and Proline

Total chlorophyll (a+b) was determined in fresh leaves using the methods described by[25]**.** Total carbohydrates percentage in dry leaves was determined using the method described by[26]. While Proline content in fresh leaves was determined according to[27]**.**

Determination of minerals content

Determination of (P, K and Na) which were determined in dry leaves using Atomic Absorption Spectrophotometer (SP 1900) as described by[28]**.**

Statistical Analysis

The collected data were subjected to statistical analysis according to[29]**.** Mean separation was done using least significant difference test at 5% level (LSD 0.05). In addition, the general mean of the main effect of 2 cuts for bacteria and compost were mathematically calculated and presented in the results.

Results

Isolation and identification of bacteria

A total of ten types of bacteria were isolated from the rhizosphere of basil growing in salt soil from Sahel El- Tina. It was observed that isolate no HA_1, HA_3, HA_5, HA_6, HA_7, HA_9 and HA_{10}; were gram negative rod while bacterial isolates HA_2, HA_4 and HA_8 were positive gram rod, all of isolates ceramist in color and slimy nature. The biochemical characteristics of the bacterial isolates are shown in Table (1).

Table (1): Biochemical characteristics of the bacterial isolates

Isolates	Gram staining	N_2-activity (µ moles C_2H_4 / ml / h)	Gibberellins (GA3) (mgL^{-1})	Indole acetic acid (IAA)(mgL^{-1})
HAI	—	7.41	150.4	70.6
HA2	+	6.91	149.3	72.3
HA3	—	N.F*	130.6	69.4
HA4	+	N.F*	125.7	69.2
HA5	—	4.21	118.4	69.1
HA6	—	3.61	109.4	68.3
HA7	—	5.61	121.6	68.9
HA8	+	1.61	100.7	52.1
HA9	—	N.F*	99.9	56.9
HA10	—	N.F*	100.8	59.4

N.F* not found

All isolates bacteria were IAA (Indole acetic acid) producers, GA_3 (gibberellins) and N_2/activity (Nitrogenase enzyme). Generally, the data show that isolate HA2 and HA_1 produced higher amount of IAA, GA_3 and gave the highest of N_2-activity compared with other isolates. The contrary occurred for isolate HA8 gave the lowest production (IAA) and (GA_3). The superior two bacterial isolates HA1 and HA2 were purified and identified through 16Sr DNA sequencing as *Azosprillum lipoferum* and. *Paenibacillus polymyxa.*

Viability of beads.

Data in Fig (1) showed that encapsulated of *Azospirillum* strain after 7 and 30 days of storages recorded the highest growth , while after 90 and 180 days the growth of encapsulated cells *Azospirillum* was decreased , recorded 66 and 40 cfu cell ml^{-1} respectively. *Paenibacillus* and *Azospirillum* were evaluated as plant growth promoters. A different trend was observed in the growth of encapsulated cells *Paenibacillus,* it recorded 67, 89 (c f u cell $ml^{-1)}$ after 7 and 30 days while it recorded 96,100(cfu cell ml^{-1}) after 90 and 180 days respectively. *Paenibacillus* encapsulated revealed maximum growth up to100 compared to *Azospirillum* , recorded 40 (c f u cell $ml^{-1)}$ after 180 days from growth .

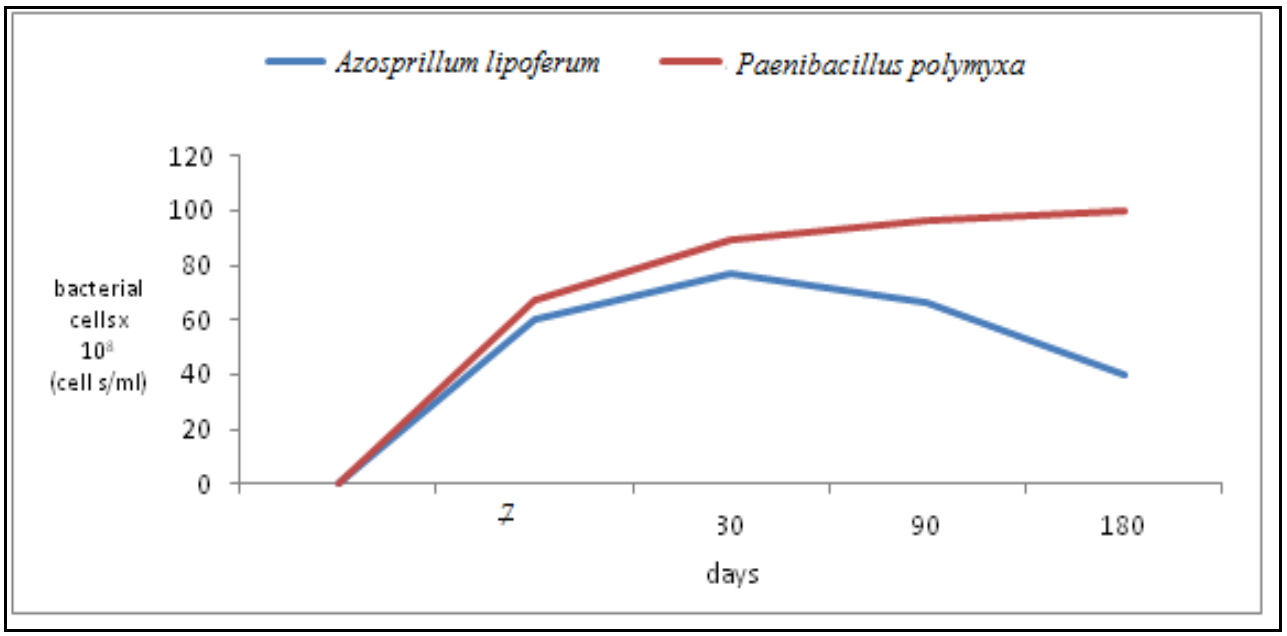


Fig (1): Viability of encapsulated cells of *Azospirillum* and *Paenibacillus* after 7, 30, 90 and 180 days.

Plant Vegetative growth characteristics:

Data showed in Tables (2-5) represent the effects of compost applications, Plant growth promoting rhizobacteris (PGPR) and their interactions during the two successive seasons of basil growth parameters as: plant height, branches no/plant, fresh and dry weights/plant.

Results from these Tables indicated that the application of different compost levels had considerable effects on the different vegetative growth characteristics of sweet basil (*Ocimum basilicum* L.) cv. "Grand Vert". In most cases, application of different compost levels promoted vegetative growth and resulted in significant increases in the values of these characteristics, compared to the control plants. Gradual increases in the above mentioned traits were noticed with the plants which received compost (20 m^3/fed) followed by that the treatment by (40 m^3/fed). These results are harmony with [30]on wheat and rice plants.

On the other hand, the inoculation with PGPR bacteria significantly increased the plant height, number of branches, herb fresh and dry weights/plant of basil plant under salinity stress compared to control. Treatment T6 recorded the highest values of these characteristics, as compared to control under salinity stress. Similar results were also observed by[31] on *Ocimum basilicum* L.

Concerning the interaction between PGPR and compost levels, significant effects on vegetative growth traits were recorded during the two tested seasons (Table 2-5). Generally, the treatment T6 amended with 20 $m^3$of compost/fed gave the highest growth parameters followed by T6 amended with 40 m^3/fed comparing to the control and all other interaction treatments. This was true during the two seasons. The application of compost and plant growth-promoting bacteria can play an important role in organic forage production. The plant height rise from 30.75cm to 56.93 cm and from 28.89cm to 53.06cm for the first cut, in the first and second seasons, respectively. Also, the number of branches rise from 11 to 18.67 and from 10 to 17 and for the second cut in the first and second seasons, respectively. While, the fresh weight/plant rise from 218.07g to 408.44g and from 215.24g to 383.25g for the second cut in the first and second seasons, respectively. Also the dry weight/plant take the same trend of the fresh weight/plant in which rise from 111.74 to 223.47g and from 109.42g to 214.34g for the second cut in the first and second seasons, respectively.

Table (2): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the plant height (cm) of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second - season								
	Compost (Com), m^3/fed.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean of(Bio)	0	20	40	Mean of(Bio)		0	20	40	Mean of(Bio)	0	20	40	Mean of(Bio)	
T1	30.75	36.97	33.85	**33.86**	25.47	34.75	30.15	**30.12**	**31.99**	28.89	34.72	31.64	**31.75**	24.12	32.33	30.45	**28.97**	**30.36**
T2	40.48	46.45	44.18	**43.70**	36.28	42.97	39.68	**39.64**	**41.67**	38.95	43.58	40.04	**40.86**	34.21	41.43	37.36	**37.67**	**39.27**
T3	45.04	50.87	48.24	**48.05**	41.70	48.30	44.45	**44.82**	**46.44**	43.70	50.56	45.60	**46.62**	40.35	46.50	43.02	**43.29**	**44.96**
T4	37.28	42.22	40.39	**39.96**	30.87	38.83	33.85	**34.52**	**37.24**	32.58	38.88	35.17	**35.54**	28.64	36.87	33.48	**33.00**	**34.27**
T5	39.94	44.91	43.10	**42.65**	32.24	40.23	36.33	**36.27**	**39.46**	35.07	40.65	38.87	**38.20**	30.47	39.61	35.85	**35.31**	**36.76**
T6	51.01	56.93	53.03	**53.66**	45.32	51.48	49.85	**48.88**	**51.27**	46.87	53.06	48.08	**49.34**	43.14	49.65	46.23	**46.34**	**47.84**
T7	43.26	47.03	45.87	**45.39**	39.66	45.18	42.43	**42.42**	**43.91**	40.12	47.64	42.35	**43.37**	38.07	43.80	40.18	**40.68**	**42.03**
Mean(Com)	**41.12**	**46.48**	**44.09**		**35.93**	**43.11**	**39.53**			**38.03**	**44.16**	**40.25**		**34.14**	**41.46**	**38.08**		
L.S.D (0.05)																		
Bio	3.105				3.251					2.154				3.241				
Com	3.362				3.540				3.105	2.225				3.742				2.311
Bio x Com	4.341				6.012					3.110				4.008				

Grand mean of compost

	First - season			Second - season		
	0	**20**	**40**	**0**	**20**	**40**
	38.53	44.80	41.81	36.09	42.81	39.17
LSD(0.05) Com	3.212			2.832		

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Table (3): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the number of branches/plant of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second - season								
	Compost (Co), m^3/fed.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean of(Bio)	0	20	40	Mean of(Bio)		0	20	40	Mean of(Bio)	0	20	40	Mean of(Bio)	
T1	9.05	11.00	10.00	**10.02**	11.00	13.27	12.05	**12.11**	**11.07**	7.57	9.60	8.60	**8.59**	10.00	12.03	11.50	**11.18**	**9.89**
T2	11.53	13.00	12.15	**12.23**	13.53	16.00	15.00	**14.84**	**13.54**	10.65	11.48	11.00	**11.04**	12.50	15.00	14.00	**13.83**	**12.44**
T3	13.17	14.40	14.00	**13.86**	15.00	17.00	16.30	**16.10**	**14.98**	12.00	13.50	12.07	**12.52**	14.45	16.00	15.07	**15.17**	**13.85**
T4	10.00	11.33	11.00	**10.78**	12.14	14.06	13.25	**13.15**	**11.97**	9.15	10.00	9.00	**9.38**	11.63	13.50	12.45	**12.53**	**10.96**
T5	11.00	12.58	12.00	**11.86**	13.00	15.33	14.00	**14.11**	**12.99**	10.00	10.83	10.50	**10.44**	12.00	14.17	13.33	**13.17**	**11.81**
T6	14.00	15.33	14.67	**14.67**	16.33	18.67	17.00	**17.33**	**16.00**	13.00	14.00	13.50	**13.50**	15.03	17.00	16.30	**16.11**	**14.81**
T7	12.00	13.17	13.00	**12.72**	14.67	16.58	15.83	**15.69**	**14.21**	11.00	12.25	11.67	**11.64**	13.55	15.45	14.50	**14.50**	**13.07**
Mean(Com)	**11.54**	**12.97**	**12.40**		**13.67**	**15.84**	**14.78**			**10.48**	**11.67**	**10.91**		**12.74**	**14.74**	**13.88**		
L.S.D (0.05)																		
Bio	0.611				0.542					0.523				0.502				
Com	0.840				0.784				**0.874**	0.422				0.677				**0.810**
Bio x Com	0.921				0.850					0.865				0.833				

Grand mean of compost

	First - season			Second - season		
	0	**20**	**40**	**0**	**20**	**40**
	12.61	14.41	13.59	11.61	13.21	12.40
LSD(0.05) Com	1.084			1.006		

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Table (4): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on fresh weight/plant (g) of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

(Bio) Treatment	First - season									Second - season								
	Compost (Co), m^3/fed.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean	0	20	40	Mean		0	20	40	Mean	0	20	40	Mean	
T1	213.84	229.00	233.07	**225.30**	218.07	245.34	250.33	**237.91**	**231.61**	199.47	214.63	220.15	**211.42**	215.24	227.22	235.04	**225.83**	**218.63**
T2	238.17	318.63	295.13	**283.98**	252.00	344.17	312.84	**303.00**	**293.49**	228.15	301.43	286.30	**271.96**	240.71	316.80	293.10	**283.54**	**277.75**
T3	246.12	341.68	328.04	**305.28**	268.67	385.68	355.50	**336.62**	**320.95**	240.41	330.00	312.46	**294.29**	253.33	358.67	340.63	**317.54**	**305.92**
T4	222.50	256.17	241.29	**239.99**	235.89	318.17	260.35	**271.27**	**255.73**	209.30	245.11	233.30	**229.24**	225.64	290.03	248.64	**254.77**	**242.01**
T5	235.67	282.33	270.34	**262.78**	245.50	337.84	282.54	**288.63**	**275.71**	217.65	268.67	251.85	**246.06**	230.35	327.14	270.15	**275.88**	**260.97**
T6	258.17	380.60	346.50	**328.42**	284.35	408.44	387.12	**359.97**	**344.20**	251.58	362.06	325.85	**313.16**	280.12	383.25	360.12	**341.16**	**327.16**
T7	241.20	330.26	313.66	**295.04**	258.11	366.11	337.54	**320.59**	**307.82**	232.20	320.50	295.50	**282.73**	248.15	341.50	323.63	**304.43**	**293.58**
Mean(Com)	**236.52**	**305.52**	**289.72**		**251.80**	**343.68**	**312.32**			**225.54**	**291.77**	**275.06**		**241.93**	**320.66**	**295.90**		
L.S.D (0.05)																		
Bio	12.410				22.322					10.651				19.452				
Com	20.243				34.045				20.055	18.754				30.236				18.412
Bio x Com	17.073				27.008					16.243				22.012				

Grand mean of compost

	First - season			Second - season		
	0	20	40	0	20	40
	244.16	324.60	301.02	233.74	306.22	285.48
LSD(0.05) Com	22.340			20.340		

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Table (5): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on dry weight/plant (g) of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second - season								
	Compost (Co), m^3/fed.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean	0	20	40	Mean		0	20	40	Mean	0	20	40	Mean	
T1	102.96	114.82	123.85	**113.88**	111.74	128.62	130.22	**123.53**	**118.71**	92.56	110.27	114.57	**105.80**	109.42	119.17	121.65	**116.75**	**111.28**
T2	121.09	170.02	157.04	**149.38**	134.90	180.42	166.02	**160.45**	**154.92**	114.10	157.77	146.19	**139.35**	120.62	167.15	157.35	**148.37**	**143.86**
T3	130.61	194.37	175.65	**166.88**	142.58	207.03	185.36	**178.32**	**172.60**	123.62	175.16	162.92	**153.90**	130.62	194.62	173.14	**166.13**	**160.02**
T4	109.30	135.43	127.05	**123.93**	122.29	157.41	137.65	**139.12**	**131.51**	100.17	123.06	119.95	**114.39**	112.63	141.65	130.45	**128.24**	**121.32**
T5	117.04	144.64	138.52	**133.40**	128.10	169.46	149.97	**149.18**	**141.29**	109.54	135.14	129.03	**124.57**	119.40	150.28	138.57	**136.08**	**130.33**
T6	135.16	210.24	187.94	**177.78**	148.26	223.47	207.84	**193.19**	**185.49**	130.17	196.35	172.94	**166.49**	137.06	214.34	189.04	**180.15**	**173.32**
T7	125.97	180.68	167.89	**158.18**	139.46	196.29	173.73	**169.83**	**164.01**	119.21	167.11	156.84	**147.72**	128.67	183.75	164.35	**158.92**	**153.32**
Mean(Com)	**120.30**	**164.31**	**153.99**		**132.48**	**180.39**	**164.40**			**112.77**	**152.12**	**143.21**		**122.63**	**167.28**	**153.51**		
L.S.D (0.05)																		
Bio	6.662				9.672					5.420				7.524				
Com	8.014				12.354				11.423	6.541				10.662				9.674
Bio x Com	12.305				17.211					9.443				14.421				

Grand mean of compost

	First - season			Second - season		
	0	**20**	**40**	**0**	**20**	**40**
	126.39	172.35	159.20	117.70	159.70	148.36
LSD(0.05) Com	12.411			11.008		

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Essential oil determinations:

Recorded data represented essential oil determinations are in Tables (6-8). Data in the first season obtained significantly increased in oil determination compared to the second season.

1 .Effect of Compost (Com) treatments:

Results in (Table 6) indicate that application of compost at 20 or 40 m^3/fed significantly increased percentage of essential oil comparing to control plants during two seasons. No significant differences were noticed in this respect between the two compost levels. The essential oil % grand mean was reached 0.275% and 0.255% comparing to 0.215% in control in the 1st season and 0.245% and 0.225 comparing to 0.189% in control plants in the 2nd season for 20 and 40 m^3/fed compost, respectively. It could be noticed that from the previous discussed results of such research that compost treatments which improved plant height, branches no/plant, herb fresh and dry weights/plant, also increased essential oil percentage. Similar results were found by [32] **on** *Foeniculum Vulgare* and[33] on Indian spinach.

For essential oil yield/plant data of (Table 7) show that application of 20 or 40 m3/fed of compost significantly increased the oil yield/plant compared to the control during two seasons. The highest compost rate (40 m^3/fed.) gave the highest grand mean of oil yield/plant (0.798 and 0.666 ml/plant in the first and second season respectively), while control plants gave significantly lower grand mean oil yields (0.535 and 0.453 ml/plant in the first and second season respectively).

Main components of essential oil (Cineol, Linalool ,Camphor and Anethol) from basil plants are shown in (Table 8). Treatment amended with 20 m^3/fed resulted in the highest percentages of the main components of the essential oil compared with control and other treatment . However, resulted in essential oil under the effect of 20 m^3/fed compost contained 39.840% Linalool, 3.916% Camphor and 18.953% Anethol. While the highest percentages of Cineol resulted under the effect of 40 m^3/fed compost.

2. Effect of PGPR application treatments:

All *PGPR* tested application treatments had significant effects on essential oil % as compare to control during the both seasons (Table 6). However, the control plants had significantly lower grand mean oil contents in the herb (0.158% and 0.132% in the first and second seasons, respectively), compared to plants receiving the different PGPR treatments. On the other hand, the highest grand mean oil contents were obtained from plants supplied with the treatment T6 (0.365% and 0.325% in the first and second seasons, respectively). Whereas the treatment which T4 gave the least effective PGPR treatments (giving grand mean values of 0.182% and 0.162% in the first and second seasons, respectively).

As for essential oil yield per plant (Tables 7) as affected by PGPR inoculation, generally , the inoculation with two forms of bacteria , had significantly effect on the resulted oil yield per plant comparing to untreated control during the two seasons. While, treated plants with T6 treatment resulted the highest significant grand mean values represented essential oil yield per plant comparing to control or treatment T 4. Similar results were corroborative in the second seasons. These data are in agreement with the conclusions reached by[34] on *Origamum majorana*.

Data showed that PGPR effects had significant effects on the essential oil components (Table 8) in basil plant, the highest percentages of Linalool, Camphor and Anethol (44.669%, 5.096% and 20.797% respectively) were recorded in essential oil extracted from plants treated with T6 While the highest percentages of Cineol (12.314%) resulted under the effect of T7 comparing to control. On the other hand, the lowest percentages of these components resulted under the treatment with T4. These data are in agreement with[35]on *Origanum majorana* and *Foeniculum vulgair.*

3. Effect of Interaction treatments between Compost and PGPR inoculation:

It is evident that the interaction between compost levels and two forms of PGPR inoculation had significant effects on essential oil % in herb of basil plant during two seasons (Table 6). Plants received 20 m^3/fed compost combined with PGPR inoculation T6 had the highest essential oil percentages comparing to all other interaction treatments during two seasons. The mean in this respect recorded 0.36% and 0.40% in the first

season while it recorded 0.33% and 0.36% in the second season at the first and second cuts, respectively followed by plants amended with 40 m^3/fed compost combined with PGPR inoculation T6 (giving values of 0.34% and 0.39% in the first season , 0.30% and 0.34% in the second season for the first and second cuts, respectively), whereas T4 recorded the least effective with 40 m^3/fed compost combined with PGPR inoculation.

The interaction between PGPR inoculation with compost levels caused significant effect on essential oil yield/plant (Table 7). Treatment T6 amended with 20 m^3/fed or 40 m^3/fed compost recorded significant increases in essential oil/plant compared to control and other interaction treatments. The highest essential oil yield/plant were recorded in the second cut of the first season comparing to all other interaction treatments during two seasons, these values were (1.634 and 1.510 ml for T6 with 20 m^3/fed or 40 m^3/fed compost, respectively).On the other hand, the lowest essential oil/plant (0.434 and 0.495ml in the first and second cuts of the first season, respectively. recorded in the plants which treated by Treatment T4 amended with 40 m3/fed compost.

Data in Table (8) stated that, the combined between 20 m^3/fed compost and PGPR inoculation T6 gave the highest values of the Linalool and Camphor with value of 50.272% and 8.872% respectively. While the combined between 40 m^3/fed compost and PGPR inoculation T6 showed the highest values of the Anethol content (23.836%) compared to control. Also, the highest values of the Cineol (16.372%) was obtained in the plants which treated by Treatment T7 amended with 20 m^3/fed compost. On the opposite, the combined between 20 m^3/fed compost and PGPR inoculation T4 gave the lowest values of the Linalool and Anethol with value of 33.498% and 16.424% respectively. While the lowest values of Camphor (2.562%) recorded in the plants that treated by Treatment T2 amended with 20 m3/fed compost.

Table (6): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the essential oil content (%) in fresh herb of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second - season								
	Compost (Com), m^3/fad.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean (Bio)	0	20	40	Mean (Bio)		0	20	40	Mean (Bio)	0	20	40	Mean (Bio)	
T1	0.13	0.16	0.17	**0.153**	0.14	0.17	0.18	**0.163**	**0.158**	0.11	0.13	0.14	**0.126**	0.12	0.14	0.15	**0.137**	**0.132**
T2	0.18	0.28	0.23	**0.230**	0.19	0.30	0.25	**0.247**	**0.239**	0.16	0.25	0.21	**0.207**	0.18	0.26	0.22	**0.220**	**0.214**
T3	0.26	0.31	0.30	**0.290**	0.28	0.35	0.34	**0.323**	**0.307**	0.23	0.28	0.27	**0.260**	0.24	0.31	0.29	**0.280**	**0.270**
T4	0.15	0.20	0.18	**0.177**	0.16	0.21	0.19	**0.187**	**0.182**	0.12	0.18	0.16	**0.153**	0.13	0.20	0.18	**0.170**	**0.162**
T5	0.17	0.24	0.21	**0.207**	0.18	0.26	0.23	**0.223**	**0.215**	0.15	0.22	0.19	**0.187**	0.17	0.23	0.21	**0.203**	**0.195**
T6	0.33	0.36	0.34	**0.343**	0.37	0.40	0.39	**0.387**	**0.365**	0.29	0.33	0.30	**0.307**	0.33	0.36	0.34	**0.343**	**0.325**
T7	0.22	0.29	0.27	**0.260**	0.24	0.32	0.29	**0.283**	**0.272**	0.20	0.26	0.24	**0.233**	0.21	0.28	0.25	**0.247**	**0.240**
Mean(Com)	**0.206**	**0.263**	**0.243**		**0.223**	**0.287**	**0.267**			**0.180**	**0.236**	**0.216**		**0.197**	**0.254**	**0.234**		
L.S.D (0.05)																		
Bio	0.021				0.036					0.018				0.025				
Com	0.035				0.043				0.023	0.027				0.038				0.021
Bio x Com	0.087				0.101					0.074				0.089				

Grand mean of compost

	First - season			Second - season		
	0	**20**	**40**	**0**	**20**	**40**
	0.215	0.275	0.255	0.189	0.245	0.225
LSD(0.05) Com	0.037			0.031		

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Table (7): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the essential oil yield/plant (ml) of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second – season								
	Compost (Com), m^3/fad.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean (Bio)	0	20	40	Mean (Bio)		0	20	40	Mean (Bio)	0	20	40	Mean (Bio)	
T1	0.278	0.366	0.396	**0.347**	0.305	0.417	0.451	**0.391**	**0.369**	0.219	0.279	0.308	**0.269**	0.258	0.318	0.353	**0.310**	**0.290**
T2	0.429	0.892	0.679	**0.667**	0.479	1.033	0.782	**0.765**	**0.716**	0.365	0.754	0.601	**0.573**	0.433	0.824	0.645	**0.634**	**0.604**
T3	0.640	1.059	0.984	**0.894**	0.752	1.350	1.209	**1.104**	**0.999**	0.553	0.924	0.844	**0.774**	0.608	1.112	0.988	**0.903**	**0.839**
T4	0.334	0.512	0.434	**0.427**	0.377	0.668	0.495	**0.513**	**0.470**	0.251	0.441	0.373	**0.355**	0.293	0.580	0.448	**0.440**	**0.398**
T5	0.401	0.678	0.568	**0.549**	0.442	0.878	0.650	**0.657**	**0.603**	0.326	0.591	0.479	**0.465**	0.392	0.752	0.567	**0.570**	**0.518**
T6	0.852	1.370	1.178	**1.133**	1.052	1.634	1.510	**1.399**	**1.266**	0.730	1.195	0.978	**0.968**	0.924	1.380	1.224	**1.176**	**1.072**
T7	0.531	0.958	0.847	**0.779**	0.619	1.172	0.979	**0.923**	**0.851**	0.464	0.833	0.709	**0.669**	0.521	0.956	0.809	**0.762**	**0.716**
Mean(Com)	**0.495**	**0.834**	**0.727**		**0.575**	**1.022**	**0.868**			**0.415**	**0.717**	**0.613**		**0.490**	**0.846**	**0.719**		
L.S.D (0.05)																		
Bio	0.201				0.234					0.175				0.228				
Com	0.253				0.290				0.224	0.192				0.275				0.217
Bio x Com	0.304				0.512					0.263				0.472				

Grand mean of compost

	First - season			Second - season		
	0	**20**	**40**	**0**	**20**	**40**
	0.535	0.928	0.798	0.453	0.782	0.666
LSD(0.05) Com	0.255			0.202		

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Table (8): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the components (%) of essential oil of *Ocimum brasillicum c.v* "Grand Vert" in the second cut of the first season 2013.

Compost (Com), m^3/fad.	Treatment (Bio)							
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**Mean(Com)**
	Cineol (Ci)							
0	5.241	8.244	7.512	6.172	7.211	13.200	9.462	**8.149**
20	6.753	11.046	8.362	8.973	10.833	9.355	16.372	**10.242**
40	8.510	16.032	13.201	7.205	10.065	7.257	11.107	**10.482**
Mean(Bio)	**6.835**	**11.774**	**9.692**	**7.450**	**9.370**	**9.937**	**12.314**	
	Linalool (L)							
0	25.043	29.385	26.324	26.680	28.634	35.822	32.426	**29.188**
20	25.514	41.726	46.806	33.498	36.411	50.572	44.352	**39.840**
40	26.782	39.517	43.462	30.147	36.763	47.613	40.208	**37.785**
Mean(Bio)	**25.780**	**36.876**	**38.864**	**30.108**	**33.936**	**44.669**	**38.995**	
	Camphor (Co)							
0	1.289	1.878	5.642	1.565	2.625	2.755	6.125	**3.126**
20	2.176	2.562	3.681	2.630	4.174	8.872	3.314	**3.916**
40	3.661	5.312	2.498	3.425	3.609	3.662	2.147	**3.473**
Mean(Bio)	**2.375**	**3.251**	**3.940**	**2.540**	**3.469**	**5.096**	**3.862**	
	Anethol (A)							
0	10.342	18.418	19.418	14.815	14.106	15.344	16.053	**15.499**
20	15.058	22.133	17.157	16.424	19.147	23.210	19.543	**18.953**
40	17.120	17.725	18.125	14.335	17.452	23.836	21.755	**18.621**
Mean(Bio)	**14.173**	**19.425**	**18.233**	**15.191**	**16.902**	**20.797**	**19.117**	

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate
(T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate. (T4) = *Azosprillum lipoferum* carried on free suspension
(T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginat
(T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Leaves chemical analysis:

Total chlorophyll (a+b) content :

Results in (Table 9) indicate that application of compost at 20 or 40 m3/fed significantly increased the total chlorophyll (a+b) in fresh leaves comparing to control plants during two seasons. No significant differences were noticed in this respect between the two levels of compost. The Total chlorophyll (a+b) content grand mean reached to 6.86 and 6.83 comparing to 5.97 mg/g F.W in control in the 1st season and 6.13 and 5.73 comparing to 5.62 mg/g F.W in control plants in the 2nd season for 20 and 40 m3/fed of compost, respectively.

In respect with the effect of PGPR on total chlorophyll (a+b), the inoculation with PGPR bacteria significantly increased the total chlorophyll (a+b) content of basil plant under salt stress as compared to control during the both seasons (Table 9). However, the control plants had significantly lower grand mean total chlorophyll content in the fresh herb (5.70 and 4.97 mg/g F.W in the first and second seasons, respectively), compared to plants inoculated with the different PGPR treatments. On the other hand, the highest grand mean total chlorophyll content were obtained from T6 (6.79 and 6.44 mg/g F.W in the first and second seasons, respectively). Whereas the treatment T4 gave the least effective PGPR

treatments (giving grand mean values of 6.57 and 5.60 mg/g F.W in the first and second seasons, respectively). Generally, the result indicated that total chlorophyll content in the first season were significantly increased compared with the second season in most treatments.

It is evident that the interaction between compost levels and two forms of PGPR inoculation had significant effects on total chlorophyll (a+b) in fresh herb of basil plant during two seasons (Table 9). Plants received 20 m^3/fed combined with PGPR inoculation T6 had the highest total chlorophyll (a+b) content comparing to all other interaction treatments during two seasons. The values in this respect recorded (7.00 and 7.20 mg/g F.W in the first season, while it recorded 6.70 and 6.90 mg/g. F.W in the second season at the first and second cuts, respectively). Whereas, the plants which treated by 40 m^3/fed combined with PGPR inoculation T4 recorded the least effective on total chlorophyll (a+b) content.

Total carbohydrates contents (% of dry matter):

Data of (Table 10) show gradual increases in total carbohydrates % in herb with increasing the applied compost concentration from 0 up to 40 m^3/fed. Results of the two seasons, respectively recorded the highest grand mean percentages of carbohydrates (32.30 and 29.30 %) under the effect of 20 m^3/fed compost followed by 31.32 and 28.12% with 40 m^3/fed compost applied. While, control treatment recorded the least total carbohydrates % as 27.10 and 23.50% in the first and second seasons, respectively.

For the effect of PGPR, results in (Table 10) show that the highest values of carbohydrates percentages were achieved during the two cuts of both of seasons by PGPR inoculation T6, followed by PGPR inoculation T3. While, the least carbohydrates percentages were occurred with control treatment and PGPR inoculation T4. The highest grand mean of total carbohydrates recorded 34.67 and 32.31% for T6 and 32.43 and 29.59% for T3 during 1^{st} and 2^{nd} seasons, respectively.

Regarding the effect of the interaction between PGPR and compost, results in (Table 10) show that the highest content of total carbohydrates were observed in treatments T6 with 20 m^3/fed and 40 m^3/fed compost in first season and second season, respectively. The highest values of carbohydrates percentages, an increase of 36.70 and 38.20 % was observed by inoculation with T6 combined with 20 m^3/fed in first and second cuts, at first season, respectively, and increase of 35.30 and 36.45% in first and second cuts, at second season, respectively as compared with control. While T4 amended with 40 m^3/fed compost recorded the lowest content in total carbohydrates compared to other treatments. That treatment gave (28.21 and 28.68% in first and second cuts, at first season, respectively.

Table (9): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on total chlorophyll (A+B) (mg/g. fresh weight) of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second - season								
	Compost (Com), m^3/fad.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean (Bio)	0	20	40	Mean (Bio)		0	20	40	Mean (Bio)	0	20	40	Mean (Bio)	
T1	5.0	5.9	6.0	**5.63**	5.2	6.0	6.1	**5.77**	**5.70**	4.7	5.0	5.0	**4.90**	4.7	5.1	5.3	**5.03**	**4.97**
T2	6.0	6.9	6.9	**6.60**	6.3	7.4	7.2	**6.97**	**6.79**	5.6	6.2	5.7	**5.83**	5.9	6.3	5.8	**6.00**	**5.92**
T3	5.9	6.9	6.9	**6.57**	6.1	7.3	7.2	**6.87**	**6.72**	5.7	6.4	5.7	**5.93**	5.9	6.7	5.8	**6.13**	**6.03**
T4	5.9	6.9	6.8	**6.53**	6.0	6.9	6.9	**6.60**	**6.57**	5.2	5.6	5.3	**5.37**	5.9	5.9	5.7	**5.83**	**5.60**
T5	5.9	6.7	6.7	**6.43**	6.4	6.9	7.0	**6.77**	**6.60**	5.3	5.8	5.4	**5.50**	5.8	6.0	5.6	**5.80**	**5.65**
T6	6.1	7.0	6.9	**6.67**	6.4	7.2	7.1	**6.90**	**6.79**	5.9	6.7	6.3	**6.30**	6.1	6.9	6.7	**6.57**	**6.44**
T7	6.0	6.9	6.8	**6.57**	6.3	7.1	7.1	**6.83**	**6.70**	5.9	6.5	5.9	**6.10**	6.0	6.7	6.0	**6.23**	**6.17**
Mean(Com)	**5.83**	**6.74**	**6.71**		**6.10**	**6.97**	**6.94**			**5.47**	**6.03**	**5.61**		**5.76**	**6.23**	**5.84**		
L.S.D (0.05)																		
Bio	0.078				0.200					0.047				0.046				
Com	0.075				0.190					0.049				0.032				
Bio x Com	N.S				N.S					0.070				0.110				

Grand mean of compost

First - season			Second - season		
0	**20**	**40**	**0**	**20**	**40**
5.97	6.86	6.83	5.62	6.13	5.73

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Table (10): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the total carbohydrates content (% of dry matter) in the herb of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Treatment (Bio)	First - season									Second - season								
	Compost (Com), m^3/fad.																	
	First cut				Second cut				Grand Mean of Bio	First cut				Second cut				Grand Mean of Bio
	0	20	40	Mean (Bio)	0	20	40	Mean (Bio)		0	20	40	Mean (Bio)	0	20	40	Mean (Bio)	
T1	23.19	25.15	25.64	**24.66**	24.33	26.07	26.45	**25.62**	**25.14**	20.38	21.45	22.00	**21.28**	21.45	23.15	23.43	**22.68**	**21.98**
T2	26.73	32.25	31.22	**30.07**	27.52	33.34	32.50	**31.12**	**30.60**	23.22	29.03	27.46	**26.57**	24.05	30.14	28.63	**27.61**	**27.09**
T3	28.64	34.63	32.82	**32.03**	29.30	35.15	34.05	**32.83**	**32.43**	24.54	32.70	29.75	**29.00**	25.33	33.46	31.75	**30.18**	**29.59**
T4	24.45	29.25	28.21	**27.30**	25.25	30.55	28.68	**28.16**	**27.73**	21.00	25.00	24.17	**23.39**	22.07	25.74	25.05	**24.29**	**23.84**
T5	26.20	31.00	30.54	**29.25**	27.00	32.02	31.63	**30.22**	**29.74**	22.82	27.11	26.71	**25.55**	23.75	28.04	27.55	**26.45**	**26.00**
T6	30.07	36.70	35.45	**34.07**	31.15	38.20	36.45	**35.27**	**34.67**	26.03	35.30	34.10	**31.81**	26.45	36.45	35.50	**32.80**	**32.31**
T7	27.40	33.25	31.75	**30.80**	28.10	34.55	33.11	**31.92**	**31.36**	23.63	30.44	28.50	**27.52**	24.28	32.15	29.05	**28.49**	**28.01**
Mean(Com)	**26.67**	**31.75**	**30.80**		**27.52**	**32.84**	**31.84**			**23.09**	**28.72**	**27.53**		**23.91**	**29.88**	**28.71**		

Grand mean of compost

First - season			Second - season		
0	**20**	**40**	**0**	**20**	**40**
27.10	**32.30**	**31.32**	**23.50**	**29.30**	**28.12**

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.
(T4) = *Azosprillum lipoferum* carried on free suspension (T5) = *Paenibacillus polymyxa*.carried on free suspension
(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* carried on free suspension

Activity of antioxidant enzymes and proline content:

The results are present in (Table 11) show the effect of PGPR and compost and their interactions on the antioxidants activity and proline content in shoots during two seasons under salinity stress.

Results in (Table 11) indicate that application of compost at 20 or 40 m^3/fed significantly dcreased antioxidants activity and proline content comparing to control plants during two seasons. No significant differences were noticed in this respect between the two compost levels. The lowest values were recorded in the plants which treated by 20 m^3/fed.

For the effect of PGPR, results in (Table 11) show that the values of peroxidase (POX), catalase (CAT) and proline contents were achieved during the two cuts of both of seasons by T1 compared to the other. While, the least POX, CAT and proline contents were occurred with PGPR inoculations. T6, followed by PGPR inoculation T7.

Concerning the interaction between PGPR encapsulated plus two different levels of compost 20 and 40 m^3 / fed significantly reduce POX, CAT activity and proline content compared to control. T1 recorded the highest increased antioxidant activity and content of proline compared to the inoculated plants during two seasons. Treatment T6 plus 20 m^3/fed gave the highest reduction in POX which recorded 3.9 and 4.6 (µM /g F wt min^{-1}), where recorded in CAT 0.05 and 0.06 (µM /g F wt min^{-1}) in first seasons and second seasons respectively, followed by T7 plus 20 m^3/fed. Obviously, The proline content increase with increasing severity of salinity stress, inoculation with PGPR compensate this effect so, the treatment T6 recorded the lowest accumulate of proline being 2.01 and 1.91 amended with 20m^3/fed during two seasons, respectively. proline content in leaves decreased with bio fertilizers amendments with compost. In other words, compost and bio fertilizers and their interaction had a significant effect on proline content in basil plant.

Mineral Contents:

Data showed in (fig 2-3) represent the effects of compost applications, Plant growth promoting rhizobacteris (PGPR) and their interactions during the two successive seasons on mineral contents of basil plant

Results from (fig 2-3) indicated that the application of different compost levels had considerable effects on the different mineral contents of sweet basil especially P, K and Na In most cases, application of different compost levels resulted in significant increases in the values of P and K but the amounts of sodium decreased compared to the control plants. Gradual increases in the above mentioned traits were noticed with the plants which received compost (20 m^3/fed) followed by that the treatment by (40 m^3/fed).

All PGPR tested application treatments had significant effects on different mineral contents of sweet basil especially P, K and Na as compare to control during the both seasons (fig 2-3). However, the control plants had significantly lower P, K contents in the herb in the both seasons compared to plants receiving the different PGPR treatments. The highest P, K contents were obtained from plants supplied with the treatment T6. Whereas the treatment which T4 gave the least effective PGPR treatments. On the other hand, the different PGPR treatments gave the lowest Na contents compared to control during the both seasons.

Regarding the effect of the interaction between PGPR and compost, results in (fig 2-3) show that Generally, Plants received 20 m^3/fed combined with PGPR inoculation T6 had the highest mineral contents as P and K comparing to all other interaction treatments during two seasons. While, The Na accumulation was significantly lower compared to control plants. Followed by T7 plus 20 m^3/fed. On the other hand, T4 amended with 40 m^3/ fed compost recorded the lowest content of P and K compared to other treatments.

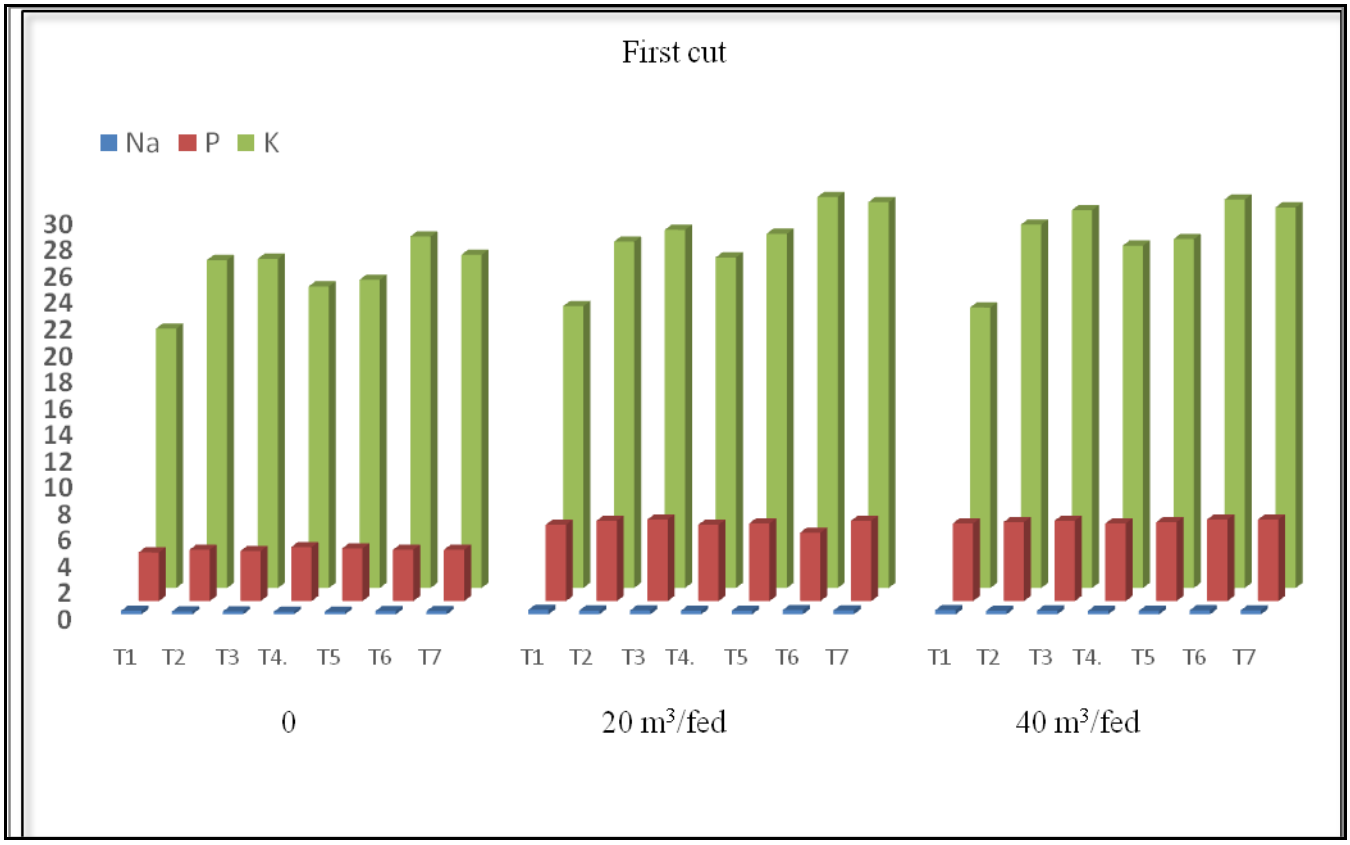
Table (11): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the activity of peroxidase (POX), catalase (CAT) and proline content in the fresh herb of of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Compost (Com), m^3/fad.	First - Season								Second - Season							
	Bio-organisms															
	T1	T2	T3	T4	T5	T6	T7	Mean (Com)	T1	T2	T3	T4	T5	T6	T7	Mean (Com)
	Peroxidase (POX), µ.M/g. fresh weight/min															
0	6.8	6.1	5.9	6.4	6.3	5.8	5.7	**6.14**	6.9	6.1	6.0	6.4	6.2	5.9	5.9	**6.20**
20	6.8	4.7	4.0	5.3	5.1	3.9	4.0	**4.83**	7.1	5.5	5.4	6.4	6.1	4.6	4.5	**5.66**
40	6.3	5.2	5.1	5.4	5.3	4.1	4.3	**5.10**	7.2	6.4	5.9	6.5	6.4	5.6	5.9	**6.27**
Mean(Bio)	**6.63**	**5.33**	**5.00**	**5.70**	**5.57**	**4.60**	**4.67**		**7.07**	**6.00**	**5.77**	**6.43**	**6.23**	**5.37**	**5.43**	
L.S.D (0.05)																
Bio	0.073								0.110							
Com	0.049								N.S							
Bio x Com	0.127								0.197							
	Catalase (CAT), µ.M/g. fresh weight/min															
0	0.14	0.12	0.11	0.13	0.11	0.10	0.10	**0.116**	0.14	0.11	0.14	0.13	0.12	0.09	0.10	**0.119**
20	0.12	0.09	0.08	0.07	0.07	0.05	0.06	**0.077**	0.11	0.08	0.07	0.09	0.07	0.06	0.06	**0.077**
40	0.11	0.08	0.07	0.08	0.08	0.06	0.06	**0.077**	0.13	0.09	0.10	0.10	0.09	0.07	0.08	**0.08**
Mean(Bio)	**0.123**	**0.100**	**0.087**	**0.093**	**0.087**	**0.070**	**0.073**		**0.127**	**0.093**	**0.103**	**0.107**	**0.093**	**0.073**	**0.08**	
L.S.D (0.05)																
Bio	0.047								0.016							
Com	0.056								0.009							
Bio x Com	0.081								N.S							
	Proline, mg/g fresh weight															
0	7.61	4.99	4.51	4.86	4.70	3.00	3.89	**4.79**	8.71	6.41	4.99	7.00	6.77	2.41	3.99	**5.75**
20	6.51	4.61	3.33	4.81	3.99	2.01	2.41	**3.95**	7.91	5.41	4.51	6.89	6.57	1.91	3.41	**5.23**
40	5.61	4.76	3.51	4.79	3.81	2.21	3.11	**3.97**	7.71	5.56	4.66	6.99	6.60	2.00	3.21	**5.25**
Mean(Bio)	**6.58**	**4.79**	**3.78**	**4.82**	**4.17**	**2.41**	**3.14**		**8.11**	**5.79**	**4.72**	**6.96**	**6.65**	**2.11**	**3.54**	
L.S.D (0.05)																
Bio	0.046								0.194							
Com	0.048								0.183							
Bio x Com	0.081								0.336							

(T1) = Control. without inoculation. (T2) = *Azosprillum lipoferum* encapsulated with sodium alginate (T3) = *Paenibacillus polymyxa* encapsulated with sodium alginate.

(T4) = *Azosprillum lipoferum* carried on free suspension, (T5) = *Paenibacillus polymyxa*.carried on free suspension

(T6) = *Azosprillum lipoferum* & *Paenibacillus polymyxa* encapsulated with sodium alginate (T7)= *Azosprillum lipoferum* & *Paenibacillus polymyxa* arried on free suspension.



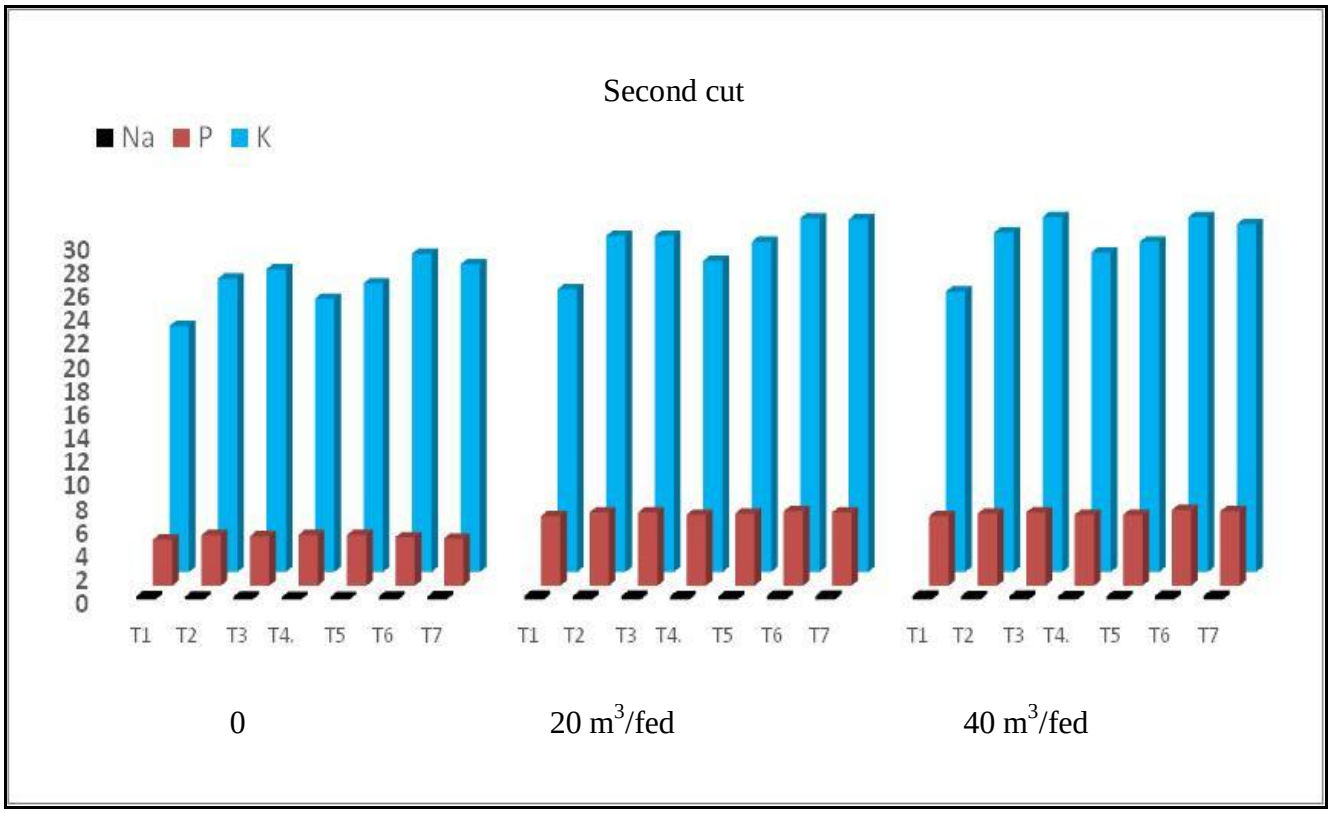


Fig (2): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the mineral contents in dry herb of *Ocimum brasillicum c.v* "Grand Vert" during 2013and 2014 seasons.

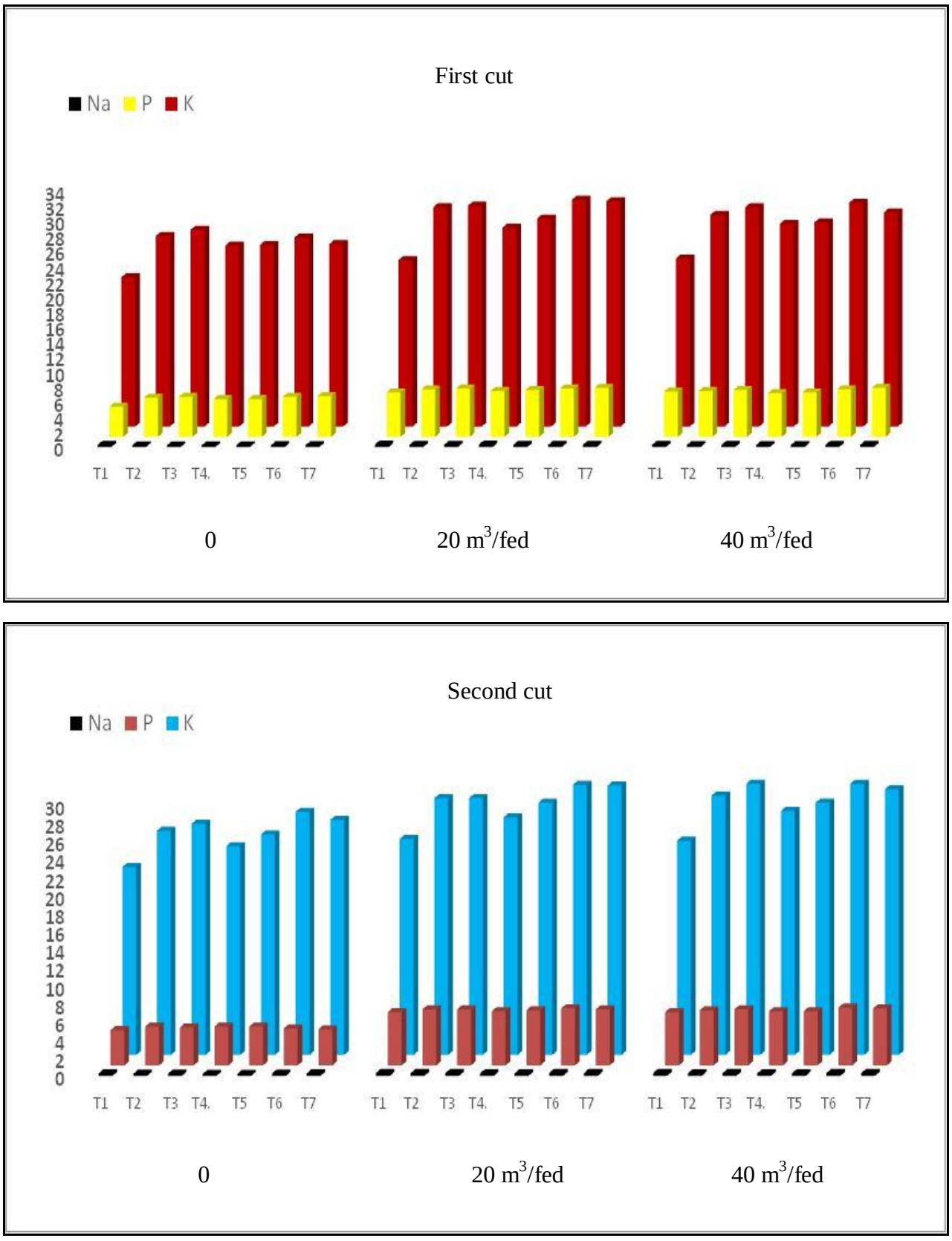


Fig (3): Reducing effect of soil salinity through using some strains of Nitrogen fixers bacteria and compost on the mineral contents in dry herb of *Ocimum brasillicum c.v* "Grand Vert" during 2013 and 2014 seasons.

Discussion

Salinity adversely affects plant growth and development. Nearly 20% of the world's cultivated area and nearly half of the world's irrigated lands are affected by salinity. Plant growth promoting rhizobacteria have been used for agricultural purposes because it can stimulate plantgrowth through different ways such as producing plant growth regulators and nitrogen fixation[36] The decrease in salinity stress may be related to salt removal due to creation of conductive pores associated with favorable soil aggregation.

The compost used in this study was a good ameliorating agent to the soil and a potential plant growth medium similarly[37]found that the biological amelioration methods using living or dead organic matter (crops, stems, straw, compost and sewage sludge) have two principals beneficial effects on reclamation of saline soils: improvement of soil structure and permeability thus enhancing salt leaching, reducing surface evaporation and inhibiting salt accumulation in surface soil. The initial effects on plants growth the beads can be forced to release the cells by mechanical crushing, while the intact beads can serve for slow release. Organic farming is one of the practices to make the production system more sustainable without adverse effects on the natural resources and the environment[38]. It not only maintains soil fertility but also conserves soil moisture[11]**.** Organic fertilizers and their extracts enhance soil fertility via improved nutrient retention and cycling and also plays an essential role in growth and yield and it increases the availability and absorption of the essential nutrient elements, such as Fe_2^+, Mg_2^+ and NH_4^+ cations, which are necessary for enzyme activation and chloroplast and chlorophyll formation[39]**.** Also, **[33]**found that the increased growth and nutrient content of plant suggest the positive effects of organic manures in amelioration of saline soils by enhancing soil fertility through the release of essential macro and micro elements. [30]found that when treated cow pea plant with organic matter (80%) in saline soil, can function as ion binding agents who detoxify the toxic ions, particularly Na^+ and Cl^-. Another study showed that O.M application to saline paddy soil is an useful remediation methods, in terms of physical, chemical and biological properties of the soil. A high concentration of organic material is essential for supporting an active bacterial pool and hence, high microbiological activity in soil**.**

The positive role of plant growth promoting rhizobacteria (PGPR) may be attributed to the vital role of such bacteria in production and accumulation of IAA and gibberellins in the plant rhizosphere, as previously mentioned in this research. However, according to [40]PGPR may be improving plant growth and increase yield productivity through different mechanisms including: Production of secondary metabolites such as antibiotic, hydrogen cyanide and plant hormones like substances, The production of siderophors, Antagonism to soil borne root pathogens, Phosphate solubilization and dinitrogen fixation.

Using of *Paenibacillus polymyxa* in forms in capsulated, which is well known for increasing exopolysaccharides (EPS) production, were the most efficient, whereas *Azosprillum lipoferum* encapsulated was less effective. These PGPR strains can produce bacterial exopolysaccharides (EPSs) that bind cations, including Na, it may postulated that increasing the population density of EPS-producing bacteria in the root zone could decrease the content of Na available for plant uptake thus helping to alleviate salt stress in plants thus helping to alleviate salt stress in plants in the inoculated plants compared to the un-inoculated in the inoculated plants compared to the un-inoculated[41]**.**In addition that, [31]which cleared that the PGPR- inoculated plants reduce stress. Environmental stress can establish higher electrolytes dischargem (like K ions) through displacement of membrane-associated Ca from plasma lemma**.** Also, [42]reports that halotolerant bacteria isolated from saline environments have potential to enhance plant growth under saline stress through direct or indirect mechanisms, Plant defense against ROS (reactive oxygen species) is related to antioxidant defense systems including catalase, peroxidase, superoxide dismutase, glutathione reductase, ascorbate peroxidase and nonenzymitic compounds includes ascorbate, α-tocopherol and carotenoides, ascorbate. Under stress, most of the rhizobacteria produce osmo-protectants (K+, glutamate, trehalose, glycine, beatine, proline and ectoine etc.) to modulate their cytoplasmic osmolarity and some others produce exopolysaccharides. Exopolysaccharides produced by pseudomonads can bind to cations including Na+ thus making it unavailable for plants under saline conditions[43]**.**

The enhancing effect of PGPR treatments on mineral absorption as P and K may be refereed to their influence on increasing the availability of such nutrients via production of plant growth regulators at the root interface, which may stimulate root development and resulted in better absorption of water and nutrients from

soil and increased plant growth which enhance the absorption of nutrients from soil[44]. However, there is some controversy regarding the mechanisms that PGPR employs for uptake of minerals. Many investigators suggested that phytohormones promote uptake of minerals by plant roots due to increase of root surface area, thickness and length[45].

Conclusion

All the applied treatments improved the growth parameters, essential oil determinations and Chemical analysis of sweet basil (Ocimum basilicum L.) cv. "Grand Vert"under saline stress, the combination of Plant growth promoting rhizobacteria (PGPR) with Compost especially T6 amended with 20 m^3/fed followed by T7 amended with 40 m^3/ fed.

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