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وحماية المستهلك

INTEGRATION OF BIOFERTILIZER WITH CHEMICAL FERTILIZER TO IMPROVE SALT TOLERANCE IN WHEAT CROP

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ABSTRACT

This study was done to estimate the PGPMs (*Rhizobium ciceri CP-93, Azospirillum brasilense, Trichoderma harzianum, Pseudomonas fluorescence, Bacillus megaterium, Lysinibacillus fusiformis*) under salinity stress for three levels 4 dS/m, 8 dS/m and 12 dS/m pot experiment were carried out in Plant Protection Directorate/ Ministry of Agriculture / Abu-Ghreeb/ Baghdad. Using wheat cultivar IPA 99 In 2022-2023 season according to Randomized Complete Block Design (RCBD). Several combinations of biofertilizers were used alone and with 25% chemical fertilizer, in addition to chemical fertilizer treatment at a concentration of 25% and 100% for comparison. Results of pot experiment showed that best treatment was (*Rhizobium ciceri CP-93* + *Azospirillum brasilense* + *Trichoderma harzianum* + *Pseudomonas fluorescence* + *Bacillus megaterium* + *Lysinibacillus fusiformis*) with 25% of chemical fertilizer which recorded significant increase in harvest index, grain number per spike and number of spikelet's/ spike in all level of salinity comparison with other treatment.

Keywords: Bacteria, Biofertilizer, IPA 99, Salinity, PGPMs.

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[*] This article is taken from the first researcher's master's thesis.

تأثير الأسمدة الحيوية مع الاسمدة الكيميائية على محصول الحنطة تحت ظروف الشد الملحي

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الخلاصة

أجريت هذه الدراسة لتقييم استخدام عدة انواع من المخصبات الحيوية هي PGPMs (*Rhizobium ciceri CP-93, Azospirillum brasilense, Trichoderma harzianum, Pseudomonas fluorescence, Bacillus megaterium, Lysinibacillus fusiformis*) تحت ظروف الشد الملحي مع ثلاث مستويات من الملوحة، المستوى الاول (4 دس/ م) ، المستوى الثاني (8 دس/م) والمستوى الثالث (12 دس/م) تم اجراء تجربة الاصص البلاستيكية في دائرة وقاية المزروعات/ وزارة الزراعة/ ابو غريب/ بغداد باستخدام صنف الحنطة اباء 99 في الموسم 2022 \ 2023 . استخدمت عدة توليفات من المخصبات الحيوية بمفردها ومع 25% من السماد الكيمياوي اضافة الى معاملة السماد الكيمياوي بتركيز 25% و 100% للمقارنة. أظهرت نتائج تجربة السنادين أن أفضل معاملة هي التي استخدم فيها السماد الكيمياوي بتركيز 25% مع المخصبات (*Rhizobium ciceri CP-93, Azospirillum brasilense, Trichoderma harzianum, Pseudomonas fluorescence, Bacillus megaterium, Lysinibacillus fusiformis*) اذ سجلت زيادة كبيرة في دليل الحصاد وعدد الحبوب في السنبلة وعدد السنيبلات في جميع مستويات الملوحة مقارنة بباقي المعاملات.

الكلمات المفتاحية :البكتريا, الاسمدة الحيوية , اباء 99, الملوحة.

INTRODUCTION

Wheat (*Triticum aestivum*) serves as the primary staple meal for almost one-third of the global population, providing over 25% of the caloric intake, as well as essential nutrients such as carbs, proteins, and certain amino acids **(Mohamed & Al–Shamary, 2022)**. In most countries of North African, and Asian including Iraq, it is the main staple food. The important crop is the wheat, as it is the first human food source because it contains 60-90% of starch, protein (16.5-11%), fats (1.5-2%), non-mineral materials (2-1.5%) and vitamins **(EL-Delfi & Safi, 2023)** . Plant development and yield are directly improved by microorganisms called plant growth promoting microorganisms (PGPMs), a collection of bacteria and fungus that act as biofertilizers when applied to soil or seeds, giving plants the required nutrients they need **(Mohmood & Zeban, 2019)**. Plant growth can be inhibited by many abiotic stressors, Salinity is one of major abiotic stress, wheat are moderately sensitive to salinity **(AL-Rawi & Hussain, 2023)**. salt stress effects on the growth, development, and yield of plants by affecting on, enzymatic processes, photosynthesis, membrane structure, hormonal balance, water and nutrient uptake, osmotic stress, ionic toxicity, and oxidative stress are all impacted by salt stress **(Zhao *et al*., 2020; Ragaey *et al*., 2022)**. PGPMs are sustainable and economical method to increase tolerance against salinity stress and improve productivity of crops, by produce plant growth regulator such as abscisic acid, ethylene, cytokinin, gibberellic acid, auxin and salicylic

acid , PGPMs are capable to convert the insoluble form of phosphorus and potassium to soluble form, Some of these microorganisms induced systematic resistance (ISR) against salt stress, and produce ACC deaminase enzymes that decrease ethylene output to reduce the inhibitory effects under salinity stress conditions **(Yasmin *et al*., 2021)**.
The aim of current study are enhancing wheat plant salinity tolerance utilizing biofertilizer with 25% chemical fertilizer.

MATERIALS AND METHODS

Pot experiment were used to find out the ability of PGPMs to improve wheat plant under salinity stress. During the growing season of 2022/2023 in the Plant Protection Directorate, Ministry of Agriculture, Abu Ghreeb, Baghdad, Iraq. The microorganisms utilized in this study were obtained from the Plant Protection Directorate with the seeds of wheat cultivation IPA 99. The microorganisms used in this study were showed in Table (1).

Table (1): Types and sources of microorganisms used as biofertilizers.

Microorganisms	Source
Rhizobium ciceri CP-93 (Rh.)	Biofertilizer laboratory /plant protection directory
Azospirillum brasilense (Az.)	Biofertilizer laboratory /plant protection directory
Pseudomonas flurescence (P.F.)	Biofertilizer laboratory /plant protection directory
Bacillus magaterium (B.m)	Biofertilizer laboratory /plant protection directory
Trichoderma harzianum (Tr.)	Plant pathology laboratory /plant protection directory
Lysinibacillus fusiformis (Ly)	Isolation from the soil

Pot Experiment

The experiment was carried out to determine the impact of biofertilizer activity on wheat under three level of salinity. The experiment was done according to split experiment with RCBD design with three replicates, Using IPA 99 wheat cultivation.
First salinity level S1: (4) dS/m.

Second salinity level S2: (8) dS/m.
Third salinity level S3: (12) dS/m.

The inoculated seeds were sowed in pot (10 Kg) of saline soil with salt gradient (4dS/m, 8 dS/m, 12 dS/m). Plastic bags were placed in the pots before putting soil to avoid soil leaching during irrigation and rain. Ten plants were grown in each pot. The pots were regularly irrigated by normal irrigation water depending on the field capacity. The treatments of this study are shown in Table (2).

Preparation of Wheat Seed With Biofertilizer:

Bacteria has been activated and grown in nutrient broth, incubated for 2 days at 28°C in a cool shaker to obtain uniform cell density 10^{7-8} cfu/ml. The viable count method was used to calculate bacterial concentration. Bacteria were inoculated on a sterilized particular carrier (charcoal, peat, 3:1, and 10% Arabic gum) at 105°C for 55 minutes at 1 bar and incubated at 28C^{o} for three days with daily shaking. The seeds were mixed with biofertilizer and sugar solution, until achieved perfect coating with carrier. The coated seeds were air dried for (1-1.5) hours in the shade **(Majeed *et al*., 2017, 2020)**.

The Treatments: treatments of this study were showed in Table (2).

Table (2): Treatments used in this study.

Symbol of treatment	**Treatments**
T1	*Rhizobium ciceri* CP-93 + *Azospirillum brasilense* + *Trichoderma harzianum*. + *Pseudomonas fluorescence* + *Bacillus megaterium* + 25% chemical fertilizer
T2	*Rhizobium ciceri CP-93*+ *Azospirillum brasilense* + *Trichoderma harzianum*. + *Pseudomonas fluorescence* + *Bacillus megaterium* + *Lysinibacillus fusiformis* + 25% chemical fertilizer
T3	*Rhizobium ciceri CP-93*+ *Azospirillum brasilense* + *Trichoderma harzianum*. + *Pseudomonas fluorescence* + *Bacillus megaterium*
T4	*Rhizobium ciceri CP-93* + *Azospirillum brasilense* + *Trichoderma harzianum*. + *Pseudomonas fluorescence* + *Bacillus megaterium* + *Lysinibacillus fusiformis*
T5	Seeds +100% chemical fertilizer control (standard amount of 100%chemical fertilizer 0.05Dap + 0.075Urea typical to 10kg soil)
T6	Seed +25% chemical fertilizer control (standard amount of 25%chemical fertilizer 0.0125g Dap + 0.01875g Urea typical to 10kg soil)

Soil Analysis

Three levels of saline soil samples were obtained (4,8,12) ds/m from field of the Plant Protection Directorate in Abu Ghreeb, Baghdad, before cultivation for physical and chemical properties. Samples from each level were taken at a depth 20-30 cm. Analysis done in the soil department laboratories, State Broad of Agriculture Research, Ministry of Agriculture, Abu-Ghreeb, Baghdad according to **(Black, 1965; pege *et al.*, 1982)**. Results are shown in Table (3).

Table (3): physical and chemical characteristics of soil before cultivation.

Parameter	measuring unit	Soil 1	Soil 2	Soil 3
PH(1:1)	---	7.66	7.52	7.81
EC(1:1)	ds /m	4	8	12
N	Ppm	32	34	32
P	Ppm	4.7	7.2	6.3
K	Ppm	118	135	121
Organic matter	%	0.76	0.62	0.53
Clay	%	45	42.5	52.5
Silt	%	25	25	30
Sand	%	30	32.5	17.5
Texture	----	Clay	Clay	Clay

Traits Studied:

At the end of the growing season of wheat, number of spikelet's spike^{-1}, length of spike, number of tillers plant-1, biological yield, harvest index and number of grain per spike has been calculated.

Harvest Index (HI) = (Grain yield / Biological yield) * 100

STATISTICAL ANALYSIS:

The experiment was conducted in split plot design RCBD with three replications. The collected data were analyzed following analysis of variance (ANOVA) using The Statistical Analysis System - SAS program **(SAS 2018)**. Mean values were compered at probability level of 0.05 (least significant difference (LSD) at $P \leq 0.05$).

RESULTS ANS DISCUSSION:

Pots Experiment:

The result of this experiment showed superiority of the treatment with biofertilizer and 25% chemical fertilizer T2 over all treatment. As a result of positive effect of biofertilizer, even under abiotic stress conditions such as salinity and drought.

The Effect of Biofertilizers Treatments under Different Salinity Levels on Number of Spikelet Per Spike:

The result in Table 4 showed supremacy to T2 in all salinity levels in the number of spikelets per spike which recorded (21.00, 19.83, 18.33) spikelets /spike in S1, S2, S3 respectively, with significant superiority over other treatments of biofertilizers and treatment of full dose of chemical fertilizer except T1 in first level of salinity S1. T6 treatment recorded the lowest result in all salinity level. Best mean recorded by T2 (19.72) spikelets /spike with significant increased over other treatment, then T1,T4 and T5 (16.94, 16.67,16.00) spikelets /spike respectively, without significant differences between them.

The interaction between salinity and treatments with biofertilizer significantly increased in most agronomic traits especially treatment of biofertilizer with *Lysinibacillus fusiformis* in combination with 25% of chemical fertilizer T2 because its plays synergistic effect with other treatment which gave better results. The data indicating that used of biofertoilizer caused increased in growth parameter and nutrient available of wheat plant under different level of salinity stress, biofertilizer have an active role to produced various growth regulators like Gibberellin, auxin and cytokinin in addition to its roles in increased nutrient viability **(Lopes *et al.*, 2021**; **Mahmud *et al.*, 2021)**.

The use of biofertilizer in this study was able to minimize the amount of chemical fertilizer used by up to 75% and the results showed that it was a better treatment for improving wheat growth and yield component, comparable to or better than full doses of chemical fertilizers.

The microorganisms have ability to decrease soil PH in saline soil as a result of activities of these microorganisms which produced more chelated ions, leading to increase available forms of element in the zone of rhizospher **(Khafagy & Abdel-Azeem, 2019).**

The present results are agreement with **(Majeed *et al.*, 2021)** they suggested that treatment with PGPMs could survive and grow in the soil under different level of salt (0dS/m, 5 dS/m, 10 dS/m, 15 dS/m), these treatment of PGPMs can reduce the effect of salt and increased the yield and growth of the wheat plant in the field compared with treatment that contain full dose of chemical fertilizer.

The results are in line with **Siswanti & Umah, (2021**) who reported that applying of biofertilizer on Amaranth plant resulted in enhanced plant height and increased leaf count in the presence of salinity stress. In addition, increased chlorophyll content when plants were exposed to salinity stress conditions.

Table (4): The effect of biofertilizers treatments under different salinity levels on number of spikelet/ spike.

Treatment	**Number of spikelet /spike**			**Mean of treatments**
	Salinity level dS/m			
	S1(4 dS/m)	**S2(8 dS/m)**	**S3(12 dS/m)**	
T1	19.67	17.83	13.33	16.94
T2	21.00	19.83	18.33	19.72
T3	18.66	16.33	11.66	15.55
T4	18.33	17.33	14.33	16.67
T5	18.33	16.00	13.66	16.00
T6	10.66	9.00	7.00	9.44
Means of salinity	17.77	16.05	13.05	---
LSD ≤0.05	**Treatment: 0.845 salinity: 0.597 Treatment x salinity: 1.460**			

The Effect of Biofertilizers Treatments under Different Salinity Levels on the Length of Spike

As shows in Table 5 the length of spike of wheat plant under three level of Salinity. In first level of salinity T2, T1 and T4 treatments recorded the highest value (10.67, 10, 10) cm without significant differences between them. In second level of salinity, T2 treatment increased significantly by (10.66) cm above all other treatments except T1 (10) cm which recorded significant differences with it. In third level of salinity, T2 treatment showed significant supremacy with all other treatments by (9.55) cm. T6 was the lowest treatments in all salinity level. Best mean with significant superiority was recorded by T2 (10.29) cm.

Different PGPMs in saline condition produce polysaccharide molecules, that have charged part react and chelate with free Na^+ ion, as a way to protect themselves from toxicity of ion **(Majeed *et al.*, 2021)**.

The result also similar to **Burjus *et al.* (2020**) who stated that the use of cyanobacteria as biofertilizer in combination with 50% of chemical fertilizer on wheat plant in soil with different salinity level (1.6 dS/m, 6 dS/m, 12 dS/m and 15 dS/m) increase yield and yield components comparable to the full dose of chemical fertilizer at all salt levels.

Table (5): The effect of biofertilizers treatments under different salinity levels on the length of spike (cm).

Treatment	Length of spike (cm)			Means of treatments
	Salinity level dS/m			
	S1(4 dS/m)	S2(8 dS/m)	S3(12 dS/m)	
T1	10.00	10.00	6.67	8.89
T2	10.67	10.66	9.55	10.29
T3	9.83	9.50	6.50	8.61
T4	10.00	9.50	8.00	9.16
T5	9.16	9.00	7.10	8.42
T6	5.66	5.16	5.50	5.44
Means of salinity	9.22	8.97	7.22	---
LSD ≤0.05	**Treatment: 0.435**	**salinity: 0.308**	**Treatment x salinity: 0.691**	

The Effect of Biofertilizers Treatments under Different Salinity Levels on the Number of Tiller / Plant

Table 6 showed supremacy of T1, T2, T3 and T5 treatments by (3.16, 3.08, 3.00) tiller /plant respectively above other treatments in S1 without significant differences between them, but with significant differences with T4 and T6 treatments by (2.58, 2.41) tiller /plant respectively. In S2 T1 and T3 treatment recorded the best result (2.83, 2.67) tiller /plant respectively (without significant differences between them) above all others treatment. In S3 T2 treatment increased significantly above all other treatments.

Bacillus spp., Trichoderma spp. and some PGPMs contributes to resisting salt stress in wheat and maize by colonization, interacting with plant root, induce sugars and antioxidant production within plant tissues and promoting growth and yield production **(Chen *et al*., 2016)**.

The results is agree with **Alotaibi *et al*. (2024)** who showed that biofertilizers improved plant tolerance to salt stress, and increased growth, grain yield, and straw productivity. They also resulted in a 25% cost reduction on mineral fertilizers used in barley production.

Table (6): The effect of biofertilizers treatments under different salinity levels on the number of tiller/plant.

Treatment	Number of tiller/plant			Means of treatments
	Salinity level dS/m			
	S1(4 dS/m)	S2(8 dS/m)	S3(12 dS/m)	
T1	3.08	2.83	1.58	2.50
T2	3.16	2.25	2.66	2.69
T3	3.16	2.67	1.50	2.44
T4	2.58	2.00	1.33	1.97
T5	3.00	2.16	1.58	2.25
T6	2.41	2.08	1.58	2.03
Mean of salinity	2.90	2.33	1.70	---
LSD ≤0.05	**Treatment: 0.323**	**salinity: 0.228**	**Treatment x salinity: 0.673**	

The Effect of Biofertilizers Treatments under Different Salinity Levels on Biological Yield

The result in Table 7 indicated that maximum biological yield was recorded in the treatments T3 and T4 (52.00, 51.33) g/plant respectively without significant differences between them in S1. T2 and T5 treatment in S2 (48.30, 45.30) g/plant respectively and S3 (36.00, 27.66) g/plant respectively was recorded the highest value with a significant superiority between them. T6 was recorded the lowest result in the biological yield in all level of salinity. The best means was recorded by T2 treatment (45.1) then T5 (41.1) and T1 (39.88) with significant differences between them.

According to **(Duo *et al.*, 2018)** *Lysinibacillus* sp. have the ability to promote plant development, increase nutrient viability, increase chlorophyll contents, and improve antioxidant enzymes. Also different PGPMs include *Pseaudomonas*, *Bacillus*, *Lysinibacillus* and *Rhizobium* improve plant growth under various abiotic conditions and increase plant tolerance to salinity stress **(Jinal *et al.*, 2019)**.

The results agree with **Al-Obaidi & Abdul-Ratha (2021)** who showed that addition of PGPMs had clear significant increase on growth and yield of green beans and increase availability of N, P and K in soil.

A study conducted by **Sadak & Dawood, (2023)** showed that the use of *Arbuscular Mycorrhiza* as a biofertilizer on wheat plants under salinity stress conditions at 4 dS/m and

8 dS/m levels resulted in an increase in wheat salinity tolerance. Additionally, it led to a decrease in the toxic effects of salinity on wheat grain yield, growth, quality, and quantity.

Table (7): The effect of biofertilizers treatments under different salinity levels on biological yield (g/plant).

Treatment	Biological yield (g/plant)			Means of treatments
	Salinity level dS/m			
	S1(4 dS/m)	S2(8 dS/m)	S3(12 dS/m)	
T1	50.66	42.66	26.33	39.88
T2	51.00	48.30	36.00	45.10
T3	52.00	35.00	24.00	37.00
T4	51.33	37.33	26.00	38.22
T5	50.33	45.30	27.66	41.10
T6	47.00	34.80	18.67	33.48
Means of salinity	50.38	40.56	26.44	---
LSD ≤0.05	**Treatment: 0.828**	**salinity: 0.585**	**Treatment x salinity: 1.551**	

The effect of biofertilizers treatments under different salinity levels on the harvest index

The result of harvest index in Table 8 showed that T2 and T5 treatments in first level of salinity (S1) recorded the highest value (43.28%, 40.56%) respectively with significant differences with all other treatments and between them. In second level of salinity (S2), T1 and T2 treatments recorded significant differences between them by (36.46%, 38.73%) respectively and with other treatments except T4 (35.04%), that did not record significant differences with T1. T2 treatment in S3(37.99 %) recorded significant superiority above all the treatments, the rest treatments did not record any significant differences between each other except T6. The treatment of 25% chemical fertilizer T6 recorded the lowest result in all salinity level. The best mean of treatments was T2 (40.01%) then T1 (36.84%) with significant differences between them.

Different PGPMs such as *Pseaudomonas*, *Bacillus*, *Lysinibacillus* and *Rhizobium* Under salt stress, it could produce phytohormones like gibbrelline, offer adequate resistance to stress caused by salt while increasing crop yield **(Enebe & Babalola, 2018)**.

The present result also similar to **Khafagy & Abdel-Azeem (2019)** who concluded that biofertilizer or potassium humate application can reduce soil salinity by improving soil fertility and reducing application of fertilizers by fixing atmospheric nitrogen, solubilizing insoluble soil potassium and phosphate.

The results are in the line with **Aechra *et al*. (2017)** who reported that biofertilizer can reduce soil salinity because the microorganisms activate in soil and dehydrogenase enzyme production in soil led to reduced salinity of the soil compared with control.

Table (8): The effect of biofertilizers treatments under different salinity levels on the harvest index%.

Treatment	Harvest index %.			Means of treatments
	Salinity level dS/m			
	S1(4 dS/m)	S2(8 dS/m)	S3(12 dS/m)	
T1	38.99	36.46	35.08	36.84
T2	43.28	38.73	37.99	40.01
T3	37.69	34.87	33.65	35.40
T4	38.30	35.04	34.22	35.85
T5	40.56	34.54	34.92	36.68
T6	31.89	29.47	26.49	29.28
Means of salinity	38.45	34.85	33.73	---
LSD ≤0.05	Treatment: 0.799	salinity: 0.565	Treatment x salinity: 1.453	

The Effect of Biofertilizers Treatments under Different Salinity Levels on Number of Grain Per Spike

Table 9 showed grain number per spike of wheat crop under three salinity level. In first level of salinity S1T2 and T1 treatment recorded the highest result (42.06, 41.60) respectively without significant differences between them, and with significant differences compared with others treatment. T2 treatment In S2 (40.30) and S3 (35.37) increased significantly above the treatments T1, T3, T4, T5, T6 by (38.60, 30.90, 36.50, 32.10, 28.33) respectively in S2 and (31.06, 26.83, 30.26, 31.36, 24.80) respectively in S3. The lowest result recorded by T6 in all salt level. All the treatment in S2 and S3 significantly decrease from S1 in the grain number per spike. The best mean of treatments were T2 (39.24) and T1 (37.08) with significant differences between them.

PGPMs such as *Pseaudomonas*, *Bacillus*, *Azospirillum* and *Lysinibacillus* can produce 1-Amino Cyclopropane- Carpoxylate (ACC) deamenase and IAA lead to promote plant growth under salinity stress. Tryptophan amino acid (precursor of Auxin) excluded by plant roots, and taken up by PGPMs present in the roots, wherever it is modified in to indol acitic acid, the microorganisms also produced IAA and to gather induce auxin signal transduction pathway to product auxin and enhancing plant growth under salinity-stress (Majeed *et al*., 2021).The microorganisms present in the root release ACC-deaminase (precursor of ethylene) and break ethylene down into α-ketobutyrate and ammonia. They reduced the amount of ethylene the plant produces and its responses to salinity stress (Ferreira *et al*., 2019).

The result is supported by **(Altaey & Majid, 2018)** which found that application of biofertilizer with kinetin in lettuce alleviated negative effect of saline water by increasing NPK contents in leaves, reduced activity of Peroxidase, Catalase, Malondialdehyde, Superoxide dismutase enzymes and proline.

The recent result agree with **(ALZuhery & Abdul Radha, 2019)** who reporting that using of biofertilizer with vermicompost and 75% of chemical fertilizer in flax plant recording significant superiority over all other treatment in(increasing the availability of Nitrogen, phosphorus and potassium in soil that gave the value 57 mg Nkg^{-1} soil, 6.13 mg Pkg^{-1} soil and 260.6 mg Kkg^{-1} soil respectively while the total (100%) chemical fertilizer recommendation gave 56 mg Nkg^{-1} soil, 2.66 mg Pkg^{-1} soil and 292.9 mg Kkg^{-1} soil respectively.

Table (9): The effect of biofertilizers treatments under different salinity levels on number of grain /spike.

Treatment	**Number of Grain/spike**			**Means of treatments**
	Salinity level dS/m			
	S1(4 dS/m)	**S2(8 dS/m)**	**S3(12 dS/m)**	
T1	41.60	38.60	31.06	37.08
T2	42.06	40.30	35.37	39.24
T3	34.56	30.90	26.83	30.76
T4	38.00	36.50	30.26	34.92
T5	38.63	32.10	31.36	34.70
T6	30.00	28.33	24.80	27.71
Means of salinity	37.47	34.45	29.95	---
LSD ≤0.05	**Treatment: 0.986**	**salinity: 0.697**	**Treatment x salinity: 1.620**	

CONCLUSIONS

The PGPMs used in this study can tolerate three level of salinity (4dS/m, 8dS/m ,12 dS/m). Under various salinity stress conditions, the microorganisms were able to grow and survive in the soil. The capacity for use them as biofertilizer in conditions of salt stress due to their capacity to mitigate the negative effects of salinity. Compared to chemical fertilizers, these microorganisms were successful in increasing growth and productivity of the wheat plant.

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