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ARTICLE

Role of Ochrobactrum Bacteria and Organic Matter in Plant Growth and the Content of N, P, and K Under Soil Salinity Stress

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ABSTRACT

Organic matter increases biological activity within the root zone because it contains beneficial microbes that stimulate vital processes. This study aimed to determine the effect of *Ochrobactrum anthropi* added to the soil as a single or mixed solution with different concentrations of organic matter on the vegetative growth of the zinnia plant and its content of nutrients. The study was conducted with a randomized complete block design (RCBD) with three replications. The plant was grown in soil with a high salinity level of 8 ds m^{-1}. Plant characteristics were estimated 30 and 60 days after planting the plant. The treatment with the addition of bio-inoculum produced the best results; within 30 days, there was a 56.89% increase in plant length; after 60 days, there was a 52.56% increase; additionally, there was a 52.56% increase in leaf count within 30 days; after 60 days, there was a 53.50% increase; and finally, there was an increase in flower count. For plants after 60 days, it reached 3.66%. With the addition of bio-inoculum to soil at a level of 3 gm kg^{-1} of organic matter, the mixing treatment achieved the highest dry weight, 29.86%. The addition of bio-inoculum resulted in the largest and most significant increase in chlorophyll content in leaves, reaching 18.76%. In the mixing addition of the biological inoculum treatment, the organic content of the plant showed an increase in nitrogen (14.38%), phosphorus (21.18%), and potassium (39.75%) at 2 and 3 gm kg^{-1} organic matter, respectively.

Keywords: *Ochrobactrum anthropi*; Organic Matter; Salt Stress; *Zinnia elegans*

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ARTICLE INFO

Received: 18 February 2025 | Revised: 4 March 2025 | Accepted: 10 March 2025 | Published Online: 23 April 2025

DOI: https://doi.org/10.30564/jees.v7i5.8777

CITATION

Hundi, H.K., Hamid, M.Q., Noori, A.A.M., 2025. Role of Ochrobactrum Bacteria and Organic Matter in Plant Growth and the Content of N, P, and K Under Soil Salinity Stress. Journal of Environmental & Earth Sciences. 7(5): 130–139. DOI: https://doi.org/10.30564/jees.v7i5.8777

1. Introduction

In contrast to other recognised methods of reclamation, such as washing the soil or depending on adding amendments, numerous recent studies have demonstrated the success of the process known as biological reclamation, or what is called biological reclamation, in which microorganisms play a role described as critical and adequate in resisting salinity and treating it [1] .This has been demonstrated in the salt-affected soils in India, Bangladesh, Nigeria, and Cyprus. Thus, biofertilizers are now considered modern technology because of their low cost and high efficacy in treating salinity and lowering soil pollution, as well as their general efficiency in boosting nutrient processing [2]. According to studies by Steinshamn et al. [3] and Tilman et al. [4], the ecosystem and biogeochemical cycles are adversely impacted by using chemical fertilisers. Consequently, plants gain from the application of biotechnology in ways other than growth and yield. Along with offering financial advantages, it also strives to enhance the environment's and the soil's health.

As a result of high temperatures and low rainfall in arid and semi-arid areas, the efficiency of nitrogenous and phosphate fertilizers added to the soil decreases, in addition to the deterioration of their properties, as the soils are structurally unstable and have low water retention capacity, which encourages the deterioration of nitrogen and phosphorus images ready for absorption by the plant, either by washing with irrigation water or by sedimentation for phosphorus, which requires the addition of high doses of nitrogenous and phosphate fertilizers on a continuous basis, which adds costs to farmers and has a negative impact on the environment. Therefore, recent research has turned to reducing the addition of nitrogenous and phosphate fertilizers through what is known as the mineral fertilization technology supported by biological inoculation (biological inoculation promoted mineral), which includes the addition of microscopic organisms, whether bacteria or fungi [5]. Hamid [6] showed that bacterial or fungal bio-inoculation, whether single or double, has a significant positive effect on soil properties and plant growth in general.

The recently adopted agricultural technologies have brought irrefutable benefits to crop production, despite the exploitation of natural resources that can result in the accumulation of pollutants and could lead to environmental contamination. The presence of naturally occurring microorganisms able to degrade does not guarantee the complete removal of pollutants from soils [7].

Ochrobactrum anthropi is a motile, gram-negative rod-shaped organism that can grow and coexist with salt conditions and produces growth hormones and amino acids [8]. It is a very important bacterial species known for its beneficial interactions with plant roots. It is a significant biological control agent [9]. In a study by Imran et al. [10], it was demonstrated that *Ochrobactrum anthropi* provides many benefits; these include the production of indole-3 acetic acid, phosphate solubilisation, production of N-acyl homoserine lactone (AHL), zinc and insoluble phosphate solubilisation, biodegradation of certain toxic compounds, and alleviation of root diseases. Several bacteria that interact with plants have been found to efficiently degrade, and regarding soil bioremediation, Gram-negative bacteria, including the genus Ochrobactrum anthropi, have been assayed with promising results. In this case, the microbe causes mainly stalk rot in plants, and its host range is wide, including the cereals rice, sorghum, wheat, as well as sugarcane, banana, and asparagus. The selection of the best bacteria for this synergy was based on their ability to degrade, associate with plant roots, and promote plant growth

All organic waste (plant and animal) is one of the most vital soil conditioners, especially for salinity-affected soils [11], and Cha-um and Kirdmanee [12] found that organic waste works to reduce the exchangeable sodium ratio and electrical conductivity and contributes to increasing the speed of sodium ion washing. It plays a vital role in lowering soil salinity and improving irrigation water quality, while also enhancing soil interactions and regulating the distribution of soil pores, which is essential for water retention and soil aeration [13]. Additionally, it helps plants tolerate salinity by altering the soil environment, promoting better root growth, and releasing organic acids that mitigate the detrimental effects of salinity [14]. Arid and semi-arid regions commonly face problems with salinity and salt stress in their soil, which affect plant growth and soil degradation. Salinity hurts the plant's ability to absorb water and maintain a balanced nutritional supply due to the osmotic pressure it produces [15]. Organic materials added to the soil, regardless of their sources, play an important role in the soil, as they directly affect the improvement of soil structure and increase the stability of its aggregates through their work in assembling soil particles according to a clear structural system due to their decomposition products. They also increase the soil's ability to retain water and are a storehouse of nutrients necessary for plant nutrition and preserving the soil surface from erosion and drift by forming aggregates through the adhesion of soil particles to each other, as they act as a binding material, thus making it difficult for them to disintegrate and drift, whether by water or wind[16]. Nawaz et al.[17] showed that salinity increases ionic toxicity, increases the rate of plant respiration, and disorganizes cell membranes and their distribution of nutrients due to the replacement of calcium by sodium and the decrease in the rate of carbon metabolism.

The zinnia (*Zinnia elegans*) plant belongs to the Asteraceae family. Its origin is Mexico. It is a beautiful ornamental plant. It bears red, orange, pink, or yellow flowers carried on 15–70 cm stems. It is considered an easy-to-care-for plant. It is one of the plants resistant to environmental conditions, including high temperatures, high salinity, and low need for humidity. It is considered resistant to drought conditions, It is an annual plant where seeds can be planted annually. It is propagated by seeds, and the plant is usually planted in the spring (March and April). The seeds usually germinate within a week. It needs light soil with an appropriate content of organic matter and small amounts of moisture, as high moisture harms the plant and exposes it to fungal diseases. It is preferable to remove the side branches of the plant to obtain large inflorescences[18].

2. Materials and Methods

The experiment was carried out in the spring of 2023 in the agricultural fields of the Department of Soil and Water Sciences at the Agriculture Faculty, University of Kufa, to assess the role of Ochrobactrum anthropi with levels of organic matter in the growth and vegetative content of nutritional elements of the zinnia plant under the influence of salinity, using mixed loam soil.

The soil with 8 ds m^{-1} in salinity was taken from 0–30 cm of the surface layer. After drying, grinding, and sieving through a 2 mm-diameter sieve, several physical and chemical analyses were performed[19, 20] (see **Table 1**).

The volume of the soil in the field was estimated based on its three dimensions (12 m length, 0.5 m width, and 0.3 m depth).

Volume = 12 m × 0.5 m × 0.3 m

Volume = 1.8 m^3 soil

Mass of soil = Density × Volume → Mass of soil = 1.35 meq.m^{-3} × 1.8 m^3

Mass of soil = 2.430 meq → 2430 kg soil

The *Ochrobactrum anthropi* vaccine was used. *Ochrobactrum* was isolated, diagnosed, and activated in the microbiology laboratories at the the Agriculture Faculty, University of Kufa. The experiment included a control group without bacterial inoculum (B0) and a treatment group with bacterial inoculum (B1). Organic matter (animal waste) was added and mixed with the soil at four levels: (0, 1, 2, and 3) gm kg–1 of soil, and the symbols were given to it (O0, O1, O2, O3). Three replicates were done. Zinnia seeds were sown there at a rate of five plants per treatment. There were 24 experimental units in total. Nitrogen and potassium fertilizers were added according to the recommended amounts. We used liquefied water, with the quantity added calculated based on 75% of the field capacity. The study period lasted for 60 days.

The experiment followed a Randomized Complete Block Design (RCBD) with three replications. The data were statistically analyzed using Statistix 10 (16), and the averages were compared using the Least Significant Difference (L.S.D) method at a probability *($P < 0.05$)*.

Measurements studied:

1. Plant lengths at the thirteenth and sixteenth days of germination using a tape measure, starting from the soil surface to the end of the plant.
2. The number of leaves at the thirteenth and sixteenth days from germination for each treatment.
3. The number of flowers at the sixteenth day after germination.
4. The dry weight of the vegetative part for each plant using a sensitive balance by separating the vegetative part for each plant and placing it in paper bags. The samples were then dried in an electric oven at a temperature of 55°C and the weight was extracted using a sensitive balance for each treatment.
5. N, P, and K concentration of the vegetative part of plants according to the method of Page, Miller and Keeney[19].
6. Chlorophyll pigment of the vegetative part (leaves)

Table 1. Some chemical and physical properties of the studied soil.

Parameters	Unit	Value	Parameters	Unit	Value
Particle Size Distribution			**Soluble Cations**		
Sand	$gm.kg^{-1}$	291.1	Ca^{++}	$Mmol.L^{-1}$	13.76
Silt	$gm.kg^{-1}$	468.00	Mg^{++}	$Mmol.L^{-1}$	8.65
Clay	$gm.kg^{-1}$	239.55	Na^{++}	$Mmol.L^{-1}$	120.01
Textural class	-	Loam	Soluble anions		
Bulk density	$mg.m^{-3}$	1.35	HCO_3^-	$Mmol.L^{-1}$	3.40
particle density	$mg.m^{-3}$	2.65	CL^-	$Mmol.L^{-1}$	115.85
Total porosity	%	49.05	SO_4^-	$Mmol.L^{-1}$	11.98
pH $(1:1)_{sups}$	-	7.80	Available nutrients		
8.7	$dS.m^{-1}$	1.1	N	$Mg.kg^{-1}$	36.5
$CaCO_3$	$gm.kg^{-1}$	255.2	P	$Mg.kg^{-1}$	4.33
OM	$gm.kg^{-1}$	2.95	K	$Mg.kg^{-1}$	44.2

of the plant, mg per 100 g fresh weight, according to the method of Goodwin [20] and Misra et al. [21].

3. Results and Discussion

1. The height of zinnia plants (cm) following 30 and 60 days of germination as a function of organic matter and *Ochrobactrum anthropi* interaction.

Tables 2 and **3** demonstrated a significant effect of the experimental factors (the bacteria and organic matter) and their interaction on the plant height characteristic. Treatment B1 significantly outperformed the control treatment (B0), reaching averages of 22.25 and 45.66 cm for the two periods. Adding organic matter at the O3 level produced the highest average plant height of 24.31 and 48.83 cm for the two periods. The interaction treatment between organic matter and Ochrobactrum anthropi influenced plant height, with the O3B1 treatment outperforming the other treatments during the two periods, with the highest rates reaching 27.00 and 51.66 cm.

The significant increase in plant height achieved by the organic matter treatments and the addition of bacteria during the two periods can be attributed to the presence of crucial nutrients in organic matter that benefit plant cells and enhance their physiological activity [22]. Organic matter contains various acids and when released by *Ochrobactrum anthropi*, it enhances the availability of nutrients, Also the organic matter in the soil is decomposed by Ochrobactrum anthropi bacteria, which leads to the release of nutrients such as phosphorus and potassium, which are important elements for plant growth. This root bacteria also plays a role in enhancing plant growth and increasing height through the role of these bacteria in producing stimulating substances that lead to the elongation of root cells and stems, thus increasing plant height [9].

Table 2. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the height of the zinnia plant (cm) after 30 days of germination.

Organic Matter O / Bacteria B	O0 0 $gm.kg^{-1}$	O1 1 $gm.kg^{-1}$	O2 2 $gm.kg^{-1}$	O3 2 $gm.kg^{-1}$	Bacterial Effects
B1	12.66	18.16	19	21.63	17.86
B2	17.33	21.66	23.00	27.00	22.25
Organic matter effect	15.00	19.91	21.00	24.31	
LSD 0.05	O	B	O*B		
	2.53	1.79	3.58		

2. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the number of zinnia leaves after 30 and 60 days of germination.

Significant differences were observed between the treatments and the averages for one treatment, as indicated by the results in **Tables 4** and **5**, where the highest average

Table 3. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the height of the zinnia plant (cm) after 60 days of germination.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	24.00	40.33	42.33	46.00	38.16
B2	34.66	47.33	49.00	51.66	45.66
Organic matter effect	29.33	43.83	45.66	48.83	
LSD 0.05	O	B	O*B		
	5.05	3.57	7.14		

number of leaves in treatment O3 was 51.83 after 60 days of germination. The number of leaves increased with the addition of bacteria, reaching 17.75 and 49.50 in the two periods; however, after 60 days of germination, the difference in the seedling treatment was not statistically significant. The number of leaves increased when treated with O3B1, after 30 and 60 days, respectively, owing to the presence of organic matter and bacteria. The explanation of the reason for this is the role of organic matter in increasing the living mass of the plant and in increasing vegetative growth rates by increasing nutrients and their readiness for the plant with the help of *Ochrobactrum anthropi* through the role of bacteria in the decomposition of organic matter and the production of nutrients such as nitrogen, phosphorus, and potassium, which are important elements for leaf growth, the most important of which is nitrogen in the formation of proteins and chlorophyll, as well as auxins produced by bacteria that stimulate cell division in buds, and also the secretion of cytokinins that delay leaf aging and enhance the formation of new leaves.This confirms the existence of a significant relationship between organic matter and bacterial resistance to salty conditions, which works to provide nutrients and give the plant resistance to these conditions These results are consistent with those of Aisha et al. [23].

Table 4. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the number of Zinnia leaves after 30 days of germination.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	9.33	17.33	14.66	14.00	13.83
B2	18.33	18.33	14.00	20.33	17.75
Organic matter effect	13.83	17.83	14.33	17.16	
LSD 0.05	O	B	O*B		
	3.16	2.23	4.47		

Table 5. Effect of organic matter and *Ochrobactrum anthropi* and their interaction on the number of zinnia leaves after 60 days of germination.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	26.66	47.00	49.66	54.66	44.50
B2	51.33	48.66	50.33	49.00	49.83
Organic matter effect	39.00	47.83	50.00	51.83	
LSD 0.05	O	B	O*B		
	7.46	5.49	10.98		

3. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the number of zinnia flowers after 60 days of germination.

Table 6 demonstrates that the number of flowers per plant increased marginally in response to organic matter levels, reaching 3.00 in O2 treated. Adding bacteria led to a significant increase in the number of flowers, reaching 3.66 compared to the control treatment (1.50), while adding organic matter with bacteria led to growth in the number of flowers, as the (O1B1) gave the highest rate, reaching 4.66 compared to the comparison treatment O0.

In addition to the role of bacteria in releasing organic acids from the organic matter (humic and fulvic acid), which help to increase the plant's vegetative growth, organic matter plays a role in nutrients and facilitating the plant's absorption of them. In addition to the role of Ochrobactrum anthropi in secreting the hormones auxins, cytokinins, and gibberellins and their role in increasing the formation of buds and their number and the number of lateral branches and thus increasing the number of flowers, as well as the role of Ochrobactrum anthropi bacteria in increasing the absorption of calcium and magnesium, which makes the flowers stronger [24].

Table 6. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the number of zinnia flowers after 60 days of germination.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	0.00	1.33	2.66	2.00	1.50
B2	3.33	4.66	3.00	3.66	3.66
Organic matter effect	1.66	3.00	2.83	2.83	
LSD 0.05	O	B	O*B		
	0.85	0.60	1.21		

4. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the dry weight (g) of zinnia plants after 60 days of germination.

Table 7 shows that adding organic matter increased the dry weight of the plant's shoots, reaching 20.36 grams in the O3 treatment while reaching 10.91 grams in the control treatment Through the role of organic matter in releasing nutrients by microorganisms in the soil, which contributes to the formation of plant biomass, as well as its role in increasing the soil's water retention, which provides continuous moisture for plants, the formation of dry matter, and the formation of organic acids that improve the plant's ability to absorb phosphorus and iron, and increase the growth and dry weight of the plant. The dry weight of the plant increased from 14.66 grams to 18.03 grams when the bacteria were added. Ochrobactrum anthropi improves nutrient absorption, enhances root growth, increases photosynthesis efficiency, and reduces the effects of environmental stress, which leads to an increase in the dry weight of zinnia plants. The presence of bacteria in the organic matter led to a notable increase in the plant's dry weight; the treated O2B1 showed the highest rate of 22.30 g, while the control treated yielded 6.66 g.

The weight of the dry stuff tends to increase when organic matter and bacteria are added, according to the data. This result was consistent with the findings of Schenck zu Schweinsberg-Mickan and Müller [25]. study, which demonstrated the natural nutrients that organic matter contains, which come from the decomposition of organic matter by bacteria, the production of acids that promote plant growth and tissue construction, and the function of bacteria in releasing growth regulators that promote plant growth and increase disease resistance.

Table 7. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the dry weight (g) of zinnia plants after 60 days of germination.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	6.66	15.16	17.83	19.00	14.66
B2	15.16	12.93	22.30	21.72	18.03
Organic matter effect	10.91	14.05	20.06	20.36	
LSD 0.05	O	B	O*B		
	3.03	2.14	4.28		

5. The effect of organic matter and Ochrobactrum anthropi and their interaction on the percentage of total chlorophyll (SPAD) of a zinnia plant after 60 days of germination.

The effects of *Ochrobactrum anthropi* and organic matter on the amount of chlorophyll in Zinnia plant leaves are exhibited in **Table 8**. The addition of bacteria and treatment of organic matter at level O3 resulted in the highest rate of chlorophyll, reaching 49.83. The organic matter treatment at level O3 reached 26.51 compared to the control treatment at 14.90. This is due to the role of organic matter in increasing the amount of chlorophyll through the availability of nutrients such as nitrogen and its role in stimulating the production of chlorophyll and the element magnesium, which is the central element of chlorophyll and the elements iron and manganese and their importance in the enzymes that manufacture chlorophyll.

It is noted from **Table 8** that the amount of chlorophyll increased with the increase in the level of organic matter and the addition of bacteria, reaching 30.85 compared to the control treatment of 9.35. The reason for this significant increase is due to the role of organic matter in increasing the absorption of nutrients, providing growth hormones, and increasing the content of chlorophyll and organic acids, in addition to the role of bacteria in improving the root system of the plant, increasing nutrient absorption, increasing its resistance to salt conditions and diseases, and its role in fixing nitrogen, increasing the solubility of phosphorus, and regulating plant growth hormones. In addition, the use of organic matter with Ochrobactrum anthropi bacteria contributes to improving and increasing soil fertility and enhancing root growth[26].

Table 8. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the percentage of total chlorophyll (SPAD) of a plant (mg per 100 g) Zinnia after 60 days of germination.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	9.35	12.44	16.66	22.16	24.69
B2	20.45	21.41	20.06	30.85	49.83
Organic matter effect	14.90	16.93	21.36	26.51	
LSD 0.05	O	B	O*B		
	1.94	1.37	2.75		

6. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the percentage of nitrogen, phosphorus, and potassium in the leaves of Zinnia plants after 60 days of planting.

The results in **Table 9** show that the percentage of nitrogen increased significantly with the addition of organic matter, and it reached its maximum rate when treated with (O3) 1.30%. This is due to the vital role of organic matter in increasing the percentage of nitrogen in the zinnia plant through the availability of basic nutrients. When they decompose, the nitrogen element is released, which increases its content for the plant. The animal fertilizer used has also proven its effectiveness in increasing the vegetative growth and flowering of the zinnia plant, which has led to an increase in the absorption of the nitrogen element and thus an increase in the nitrogen content in the plant tissues according to what Nikipelova et al. found[27]. The addition of *Ochrobactrum anthropi* resulted in a considerable increase in the percentage of nitrogen, reaching 1.28% through the role of Ochrobactrum anthropi bacteria in converting atmospheric nitrogen into forms that can be absorbed by the plant and also improving the absorption of other nutrients in the soil, which enhances the absorption of the nitrogen element in the soil. However, the interaction between the bacteria and organic matter revealed significant variances, with O2B1 having the highest rate when treated (1.46%).

Table 10 results show that adding organic matter significantly increased the plant's phosphorus percentage, with the maximum rate gaining 1.72% after treatment with O3. Furthermore, the addition of bacteria resulted in a notable rise in the percentage of phosphorus, with the greatest percentage reaching 1.64 at the (B1) level. In O3, there was a rise in the potassium content, gaining 2.22%. Similarly, the mixing treatment (2.44%) yielded the highest percentage when treated with O3B1.

Table 9. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the percentage of nitrogen, phosphorus, and potassium in the leaves of Zinnia plants after 60 days of planting.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	0.21	0.39	1.14	1.12	0.71
B2	1.04	1.21	1.46	1.42	1.28
Organic matter effect	0.63	0.80	1.30	1.27	
LSD 0.05	O	B	O*B		
	0.05	0.03	0.07		

The results from **Tables 9–11** show that adding organic matter and bacterial inoculation significantly affects the levels of nitrogen, phosphorus, and potassium. This is because bacteria secrete many growth regulators, which enhance root growth and biological activity while increasing the solubility of nutrients. These beneficial bacteria promote plant growth and nutrient absorption, in addition to reducing the consumption of irrigation water added during the growth process [28].

Table 10. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the phosphorus percentage of zinnia leaves after 60 days of planting.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	0.43	0.98	1.05	1.41	0.97
B2	1.02	1.66	1.85	2.03	1.64
Organic matter effect	0.72	1.32	1.45	1.72	
LSD 0.05	O	B	O*B		
	0.07	0.05	0.10		

Table 11. The effect of organic matter and *Ochrobactrum anthropi* and their interaction on the percentage of potassium% of zinnia leaves after 60 days of planting.

Organic Matter O / Bacteria B	O0 0 gm.kg^{-1}	O1 1 gm.kg^{-1}	O2 2 gm.kg^{-1}	O3 2 gm.kg^{-1}	Bacterial Effects
B1	0.97	1.04	2.05	2.00	1.51
B2	2.00	2.03	2.17	2.44	2.16
Organic matter effect	1.48	1.54	2.11	2.22	
LSD 0.05	O	B	O*B		
	0.09	0.06	0.12		

4. Conclusions

Salinity is a global environmental problem that has a negative impact on plant growth and adaptability. Based on results, the use of Ochrobactrum anthropi bacterial inoculum alone or mixed with levels of organic matter could be the best option to reduce the negative impact of salinity and enhance adaptability. This is consistent with our findings in the research. There is an increase in plant vegetative growth and an increase in the availability of nutrients nitrogen, phosphorus and potassium for the plant. Therefore, it is recommended to use bacterial inoculum with organic matter to achieve the best plant growth under the influence of salt.

Author Contributions

All authors contributed equally to all stages of the study, from conceptualization and study design to data collection, analysis, writing of the manuscript, and final approval of the published version.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Data will be available on request from the author.

Conflicts of Interest

The authors declare no conflict of interest.

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