The role of humic acids, salt stress and bacterial inoculum in some soil properties and nutrient available

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Abstract
A field experiment was conducted in one of the private farms in Babylon province / for the winter season of the year (2024-2023), to study the role of bacterial inoculum and humic acids in treating salt stress and improving some soil properties. The study included three factors: the quality of irrigation water (river water with a salt concentration of 1.4 dSm-1 and mixing water with a salt concentration of 3.6 dSm-1 W1 and well water 7.0 dSm-1) and symbolized by the symbol (W0, W1, W2) The second factor is adding the bacterial inoculum, which is Azotobacter chroococcum bacteria loaded on peat moss and the symbol for the treatments (without adding (A0) and adding the Azotobacter bacteria inoculum(A1) The third factor is adding humic acids At three levels (0, 25, 50), a factorial experiment was conducted according to the Split-Split Plot arrangement and the Randomized Complete Block Design (RCBD) design with three replicates. The averages were compared according to the Least Significant Difference (LSD) test at the 0.05 level. The results showed that river water W0 was significantly excelled and gave the highest rate of organic matter in the soil after harvest, reaching 12.85 mg.kg-1, bacterial count 1.84 Cfu.g dry soil, and available phosphorus 23.16 mg.kg-1, while the well water treatment (W2) recorded the highest rate of available nitrogen, reaching (54.41 mg.kg-1, available potassium 252.96 mg.kg-1. While the treatment of humic acids at a concentration of 50 kg.h-1 (H2) was excelled and gave the highest rate of organic matter content in the soil 11.89 mg.kg-1, bacterial numbers 1.26 Cfu.g dry soil, available nitrogen 51.44 mg.kg-1, available phosphorus 18.16 mg.kg-1, available potassium 193.33 mg.kg-1, The results also showed that the bio-inoculation had a significant effect, as the treatment of Azotobacter bacteria (A1) was recorded and gave the highest rate of organic matter content in the soil 12.04 mg.kg-1, bacterial numbers 1.46 Cfu.g dry soil, available nitrogen 51.66 mg.kg-1, available phosphorus 18.09 mg.kg-1, available potassium 197.81 mg.kg-1, the triple interaction treatment W2A1H2 was significantly excelled and gave the highest rate of organic matter content in the soil, reaching 13.96 mg.kg-1, available nitrogen 59.23 mg.kg-1, available potassium 290.14 mg.kg-1, and the W0A1H2 treatment was excelled and recorded the highest rate of bacterial numbers, reaching 2.41 Cfu.g dry soil, available phosphorus 28.52 mg.kg-1
Keyword: humic acids, salt stress, Azotobacter chroococcum, river water, well water

Introduction

Many areas in the world suffer from the problem of salinity and one-third of agricultural lands around the world are affected by salinity [38]. The problem of salinity is considered one of the serious problems facing agriculture at the present

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time, as the tolerance of plants to salinity is one of the important issues that has attracted the attention of researchers and workers in the agricultural fields because of the need to increase production and use large areas of land for the purpose of cultivation [26]. Soil salinity affects plant growth in several ways through the harmful effects of salinity of irrigation water, which leads to the accumulation of salts in the soil, which reduces ready elements, delays germination, slows the growth rate, early wilting and dwarfing of plants [33]. As a result of the increasing problem of water shortage in arid and semi-arid areas, it was necessary to search for alternative sources of water that can be exploited, especially in areas with limited water resources. Including well and drain water, and it is expected that this problem will continue and increase, so alternatives must be found to compensate for the use of fresh water to fill part of the expected water deficit. One of the techniques adopted in such circumstances is the reuse of drainage water from agricultural drainage [35] which is characterized by high concentrations of dissolved salts. Within this concept, there are many determinants of the suitability of this water for irrigation purposes that must be taken into account. These factors include the chemical components of the water, crop quality, soil and water management in order to overcome the negative effects that this water may cause while maintaining soil productivity in the long term. Wheat is classified as the third most widely grown cereal crop in the world after rice and maize [30]. Due to the steady increase in population, the demand for this crop is increasing, as the global wheat production is estimated at 757.6 million tons [19], with the need to increase the production rate by 50% by 2030 to cover the growing population needs in the world [21]. Studies have shown that wheat yield can be increased by adding mineral and biological fertilizers, which meet the needs of this crop through balanced fertilizer combinations of bacterial biofertilizers [3]. One of the methods used in reclamation of saline soil is the use of biological methods using bacterial species that are tolerant to salinity, such as the free-living Azotobacter species in the soil [13]. The increased efficiency of wheat varieties in absorbing nutrients is greatly affected by the presence of these organisms, which have positive effects on plant growth. Most of them are found in the rhizosphere and are known as bacteria that promote plant growth, as inoculation with these bacteria increases the ability of plants to resist salinity by producing various hormones and preparing nutrients. In addition, they work to increase plant growth and improve its performance under salt stress, which leads to increased production [40]. Azotobacter bacteria have the ability to fix atmospheric nitrogen biologically, prepare soluble nutrients and polysaccharides, and secrete salicylic acid, thus improving plant growth under salt stress conditions [34]. Humic acids (humic acid and fulvic acid) are considered organic soil conditioners for saline soils, as adding humic acids to the soil helps to wash away salts, reduce electrical conductivity and sodium adsorption rate, and regulate pH. This is due to the effectiveness of humic acids in forming compounds that are easy to wash because they contain active carboxylic and hydroxyl groups that form complexes with salt ions and make them easy to wash [43]. Through them, the efficiency of the soil reclamation process affected by salts can be increased. Many researchers have concluded that organic and biological fertilization led to an increase in the concentration of soil elements when planted with different crops [16]. In view of the above, this study aims to know the role of bacterial inoculum (azotobacter) and humic acids in reducing salt stress and improving the chemical properties of the soil and biological fertility.

Materials and methods

A field experiment was coundected in one of the private farms in Babylon Province / for the winter season of the year (2023-2024), to study the role of bacterial inoculum and humic acids in treating salt stress and improving some chemical properties of the soil. Random samples were taken from different places of the soil of the experimental field and from a depth of (0-30) cm, then air-dried and crushed with a polyethylene hammer and sieved through a sieve with a hole diameter of 2 mm)) then mixed well and samples were taken from it to conduct chemical and physical analyses as in (Table 1.(

Table (1): Some chemical and physical properties of the study soil before planting

units	Values	traits	
------	7.87	pH	
dsm^{-1}	5.67	Electrical conductivity	
centimole.charge.kg-1	22.67	Cation exchange capacity	
g.kg-1	9	Organic matter	
	361	Carbonate minerals	
Dissolved ions in saturated soil paste extract ($mmol.L^{-1}$)			
)$mmol.L^{-1}$(	14.27	Calcium	Dissolved positive ions
	10.45	Magnesium	
	0.93	Potassium	
	20.27	Sodium	
	Nill	Carbonates	Dissolved negative ions
	4.67	Bicarbonates	
	9.37	Sulfates	
	32.05	Chlorine	
$mg.kg^{-1}$	15	Nitrogen	available elements
	6.12	Phosphorus	
	124.02	Potassium	
$g.kg^{-1}$	572	sand	Sandy loam particle size analysis
	380	Silt	
	48	clay	
$Mg.m^{-3}$	1.31	Bulk density	
$Mg.m^{-3}$	2.63	Particle density	

Water samples were taken from the river and from a well located near the field to a depth of 0.3 m [10] to conduct chemical analysis of water parameters and the water type was determined according to [16]. Table (2) shows the chemical properties of irrigation water

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Table (2): Chemical properties of irrigation water types

traits											
SAR	Negative ions (mmol L^{-1})				Positive ions (mmol L^{-1})				PH	EC dsm^{-1}	Irrigation water types
	SO_4^{-2}	CL^-	$^{=}CO_3$	$HCO3^-$	Mg^{+2}	Ca^{+2}	K^+	^{+}Na			
2.41	3.73	4.52	Nill	1.00	1.82	2.24	0.07	4.85	7.71	1.4	River water W0
6.21	5.88	16.53	Nill	1.41	3.93	2.82	0.12	16.14	7.59	3.6	Mixed water W1
6.40	9.61	39.01	Nill	1.84	10.33	6.33	0.21	26.14	7.48	7	Well water W2

The field was prepared before planting by plowing, and the field was divided according to the design used according to the experimental units with dimensions (3m X 2) for each experimental unit. Each main plot was isolated from the other by a distance of 2m, each subplot was isolated from the other by a distance of 1.5m, and each sub-subplot was isolated from the other by a distance of 0.50m to facilitate crop service and prevent the movement of water and salts and interference between the different treatments. Wheat seeds were planted, variety IPA99, with a seed quantity of 140 kg.ha-1, according to the recommendations of the Iraqi Ministry of Agriculture. The field was fertilized with nitrogenous, phosphate and potassium fertilizers, according to the fertilizer recommendations, where phosphate fertilizer was added 15 days before planting at an amount of 100 kg ha-1P2O5 (20%P) in one batch at planting [25]. Potassium fertilizer was added at an amount of 120 kg ha-1 (K2SO4 51%) to the soil and for all treatments in two equal batches, the first at planting and the other at the lining stage. The nitrogen fertilization process was carried out at an amount of 200 kg ha-1 in the form of urea fertilizer ((N%46) in three batches at the stages (beginning of planting, branches and lining) as in [7]. At planting, the field was irrigated with fresh water (germination irrigation), after which Irrigation according to the water parameters used in the study, which is the first factor, water types, including river water with a salt concentration of 1.4 dSm-1, symbolized by the symbol W0, and mixing water with a salt concentration of 3.6 dSm-1 alternately, symbolized by the symbol W1, and well water with a salt concentration of 7.0 dSm-1, symbolized by the symbol W2. The second factor included biofertilization by adding bacterial inoculum (A). The Azotobacter chroococcum bacteria inoculum was used, loaded on peat moss and produced in the laboratories of the Agricultural Research Department of the Ministry of Science and Technology / Zaafaraniya. The inoculum was added according to the experimental parameters in the lines prepared for planting seeds at a depth of 5 cm, so that the biofertilizer is in direct contact with the roots of the plants when they emerge, and the symbol for the parameters is (without adding the inoculum, symbolized by A0) and (adding the Azotobacter bacteria inoculum, symbolized by A1). The third factor included organic fertilization, where humic acids were used, as they were The soil addition was done at three levels (without addition and

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symbolized by the symbol (H0), adding humic acids at a level of 25 kg ha-1 and symbolized by the symbol (H1), and adding humic acids at a level of 50 kg h-1 and symbolized by the symbol (H2). Weeding and weeding were carried out whenever necessary during the plant growth season.

Experimental design of field experiment treatments

A factorial experiment was carried out according to the split-split plot arrangement and the RCBD design with three replicates, where each replicate contains 18 treatments, so that the number of experimental units becomes 54) experimental units). The irrigation water quality factor occupies the main plot, while the bacterial inoculum factor occupies the secondary plots (sub plot), and the addition of humic acids occupies the sub-sub plot.

Studied traits

-1Organic matter in soil: Organic matter was estimated by wet digestion method according to the Walkly and Black method as mentioned in [36[

-2Number of Azotobacter bacteria

Number of Azotobacter bacteria was estimated by dilution pour plates method described by [36] in estimating Azotobacter bacteria, where a series of dilutions were prepared according to the method described by) [35] for each soil sample.

available macro nutrients

.1available nitrogen

available nitrogen was extracted from the soil with potassium chloride solution (2 N) using the (Micro Kjeldahl) device and according to the method of [36.[

.2available phosphorus

The method of Olsen et al. (1954) was used for extraction using sodium bicarbonate solution (0.5 N) at pH=8.5. The color was developed with ammonium molybdate and ascorbic acid and was estimated using a spectrophotometer at a wavelength of 882 nm as mentioned in [36.[

.3available potassium

available potassium was estimated by extraction using ammonium acetate solution (NH4OAC 1N), pH=7 using a flame photometer

Results and discussion

-1Soil organic matter content after harvest (mg.kg-1 soil(

The results of Table (3) showed that the type of irrigation water had a significant effect on the rate of organic matter in the soil after harvest (mg.kg-1 soil). Well water (W0) was significantly excelled to the other treatments and gave the highest rate of organic matter in the soil after harvest, reaching 12.85 mg.kg-1 soil, while mixing water (W1) gave average of organic matter in the soil after harvest, reaching 11.33 mg.kg-1 soil, while the river water treatment (W0) recorded the lowest rate of organic matter in the soil after harvest, reaching 10.19 mg.kg-1 soil.The bio-inoculum also had a significant effect on the organic matter content in the soil after harvest. The treatment of adding Azotobacter bacteria (A1) recorded the highest rate of organic matter in the soil after harvest, reaching 12.04 mg. kg-1 soil, significantly excelled to the treatment without addition (A0), which recorded the lowest rate of organic matter in the soil after harvest, reaching 10.87 mg. kg-1 soil. It is noted that the addition of humic acids has a significant effect in increasing the organic matter content in the soil after harvest. The treatment of adding humic acids at a concentration of 50 kg. h-1 (H2) was significantly excelled and gave the highest rate of 11.89 mg. kg-1 soil, followed by the treatment of adding at a concentration of 25 kg. ha-1 (H1) and gave average of organic matter in the soil after harvest of 11.39 mg. kg-1 soil, while control treatment (H0) gave the lowest rate of organic matter in the soil after harvest of 11.09 mg. kg-1 soil. It is also noted from the same table that the bi-interactions between the bacterial inoculum and the quality of irrigation water (W*A) have a significant effect on the organic matter content in the soil after harvest. The treatment W2A1 recorded the highest rate of organic matter in the soil after harvest of 13.64 mg. kg-1 soil in While the W0A0 treatment gave the lowest rate of organic matter, which reached 9.77 mg. kg-1 soil, the interaction treatment between irrigation water quality and humic acids W2H2 recorded the highest rate of organic matter in the soil after harvest, which reached 13.43 mg. kg-1 soil, while the W0H0 treatment recorded the lowest rate of organic matter in the soil after harvest, which reached 9.80 mg. kg-1 soil. The interaction treatment between bacterial inoculum and humic acids A1H2 also significantly excelled and recorded the highest rate of organic matter in the soil after harvest, which reached 12.35 mg. kg-1 soil, while the interaction treatment A0H0 recorded the lowest rate of organic matter in the soil after harvest, which reached 10.41 mg. kg-1 soil.The interaction of the three study factors of irrigation water quality, bacterial inoculum and humic acids had a significant effect on the rate of organic matter in the soil after harvest (mg. kg-1 soil). The interaction treatment W2A1H2 significantly excelled the other interaction treatments and recorded the highest rate of organic matter in the soil after harvest, reaching 13.96 mg. kg-1 soil, while the treatment W2A0H0 gave the lowest rate of organic matter in the soil after harvest, reaching 9.40 mg. kg-1 soil .

Table (3) Effect of irrigation water quality, addition of bio-inoculum, humic acids and their interaction on the content of organic matter in the soil after harvest

Bacterial inoculum x Irrigation water quality) W*A(	Adding of humic acids (H)			Bacterial inoculum(A)	Irrigation water quality W
	50kg.ha-1(H2)	**25kg.ha-1(H1)**	Without adding H0)(		
9.77	10.12	9.81	9.40	Without adding (A0)	River water W0
10.60	10.97	10.64	10.20	Azotobacter bacteria (A1)	
10.78	11.27	10.82	10.26	Without adding (A0)	Mixed water W1
11.88	12.12	11.71	11.80	Azotobacter bacteria (A1)	
12.06	12.90	11.71	11.57	Without adding (A0(	Well water W2
13.64	13.96	13.65	13.32	Azotobacter bacteria (A1(	
0.07	0.11			L.S.D 0.05	
Average Irrigation water quality(W)	Interaction between Irrigation water quality and humic acids (H*W)				
10.19	10.54	10.23	9.80	River water W0	
11.33	11.69	11.26	11.03	Mixed water W1	
12.85	13.43	12.68	12.44	Well water W2	
0.05	0.08			L.S.D 0.05	
Average Bacterial inoculum(A(	Interaction between bacterial inoculum and humic acids (H*A(				
10.87	11.43	10.78	10.41	Without adding (A0(	

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12.04	12.35	12.00	11.77	Azotobacter bacteria (A1(
0.04	0.07			L.S.D 0.05
	11.89	11.39	11.09	Average humic acids (H)
	0.05			L.S.D 0.05

The results of Table (3) showed that organic matter has a positive role in reducing the damage that occurs to plants directly and indirectly, and its indirect role lies in reducing the negative effect of salt stress by improving soil structure and increasing salt washing and . The percentage of organic matter increases with increasing salinity, and the reason for this increase is due to the effect of the salinity of irrigation water, as salts play a role in inhibiting the biological activity of soil microorganisms and thus reducing the rate of decomposition of organic matter during the cultivation period, causing an increase in the soil content of organic matter [44] especially the effect of sodium and chloride ions, which leads to inhibition of microbial growth in saline soil [46]. The results showed that the bacterial bio-inoculation has a significant effect in increasing the soil content of organic matter, and the reason for this is attributed to the increase in root growth and secretions. The reason can also be attributed to the fact that microorganisms die after a period of time, leaving their cells in the soil, thus increasing the organic matter in the soil Adding humic acids to the soil also increases the soil content of organic matter, thus improving the soil structure, which helps wash away salts and reduce their accumulation in the root zone[5,15,24 [

Bacterial counts (cfu.gm dry soil(

The results of Table (4) showed that the type of irrigation water had a significant effect on the rate of bacterial counts in the soil (cfu.gm dry soil). River water (W0) was significantly excelled to the other treatments, giving the highest rate of bacterial counts, reaching 1.84cfu.gm dry soil, and mixing water (W1) gave average of bacterial counts of 1.09cfu.gm dry soil, while the treatment of water recorded Well (W2) had the lowest bacterial count rate of 0.56 cfu.gm dry soil.The results also showed that the bio-inoculum had a significant effect on bacterial counts, as the treatment of adding Azotobacter bacteria (A1) recorded the highest bacterial count rate of 1.46 cfu.gm dry soil, significantly excelled to the treatment without addition (A0), which recorded the lowest bacterial count rate of 0.87 cfu.gm dry soil. As for humic acids, the results showed that adding humic acids had a significant effect in increasing the number of bacteria. The treatment of adding humic acids at a concentration of 50 kg. ha-1 (H2) was significantly excelled and gave the highest rate of 1.26 cfu. gm dry soil, followed by the treatment of adding at a concentration of 25 kg. ha-1 (H1) and gave a bacterial count rate of 1.19 cfu. gm dry soil, while control treatment (H0) gave the lowest bacterial count rate of 1.04 cfu. gm dry soil. As for the dual interactions, the results showed that the dual interactions between the bacterial inoculum and the quality of irrigation water (W*A) had a significant effect on the number of bacteria. The treatment W0A1 recorded the highest bacterial count rate of 2.23 cfu. gm dry soil, while the treatment W2A0 recorded the lowest bacterial count rate in the soil, reaching 0.50 cfu.gm dry soil. The interaction treatment between irrigation water quality and humic acids W0H2 recorded the highest bacterial

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count rate, reaching 2.06 cfu.gm dry soil, while the W2H0 treatment recorded the lowest bacterial count rate, reaching 0.41 cfu.gm dry soil. The interaction treatment between bacterial inoculum and humic acids A1H2 was significantly excelled, recording the highest bacterial count rate, reaching 1.61 cfu.gm dry soil, while the interaction treatment A0H0 recorded the lowest bacterial count rate, reaching 0.83 cfu.gm dry soil.Table (4) also showed that the triple interaction between the experimental factors of irrigation water quality, bacterial inoculum and humic acids had a significant effect on the bacterial count rate (cfu.gm dry soil). The interaction treatment W0A1H2 significantly excelled the other interaction treatments and recorded the highest bacterial count rate of 2.41 cfu.gm dry soil, while the treatment W2A0H0 gave the lowest bacterial count rate of 0.32 cfu.gm dry soil .

Table (4) Effect of irrigation water quality, addition of bio-inoculum, humic acids and their interaction on bacterial count (cfu.gm dry soil(

Bacterial inoculum x Irrigation water quality) W*A(	Adding of humic acids (H(			Bacterial inoculum(A(	Irrigation water quality W
	50kg.ha-1)H2(	**25kg.ha-1)H1(**	Without adding (H0(		
1.46	1.72	1.43	1.23	Without adding (A0(	River water W0
2.23	2.41	2.36	1.91	Azotobacter bacteria (A1(	
0.66	0.41	0.63	0.93	Without adding (A0(	Mixed water W1
1.50	1.67	1.52	1.33	Azotobacter bacteria (A1(	
0.50	0.61	0.55	0.32	Without adding (A0(	Well water W2
0.63	0.73	0.66	0.51	Azotobacter bacteria (A1(	
0.011	**0.0193**			L.S.D 0.05	
Average Irrigation water quality(W(	Interaction between Irrigation water quality and humic acids (H*W(				
1.84	2.06	1.90	1.57	River water W0	
1.09	1.05	1.08	1.13	Mixed water W1	
0.56	0.67	0.61	0.41	Well water W2	
0.008	**0.014**			L.S.D 0.05	
Average Bacterial inoculum(A(	Interaction between bacterial inoculum and humic acids (H*A(				
0.87	0.92	0.87	0.83	Without adding (A0(	
1.46	1.61	1.52	1.25	Azotobacter bacteria (A1(	
0.006	**0.0111**			L.S.D 0.05	
	1.26	1.19	1.037	Average humic acids (H(	
	0.008			L.S.D 0.05	

It is noted from Table (4) that the effect of irrigation water salinity on the number of Azotobacter bacteria in the soil is due to the fact that the increase in irrigation water salinity plays a role in inhibiting the vital activity of microorganisms, and the decrease in the number of bacteria at high salt concentrations may be attributed to the toxicity of salt ions and the increase in osmotic pressure, which affects the physiology of the cell and its metabolic pathways [37].

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Inoculation with Azotobacter bacteria leads to increased plant resistance to salinity through the production of various hormones and the preparation of nutrients, in addition to the fact that it works to increase plant growth and improve its performance under salt stress [40]. The variation in the number of bacteria is attributed to the difference in environmental and climatic conditions, soil type, type of cultivated plant, and organic matter in the soil [39]. The addition of organic acids led to a significant increase in the number of Azotobacter bacteria, which indicates the role of organic matter in activating and increasing the number of Azotobacter bacteria, as they are heterotrophic bacteria that use organic matter as a source of carbon and energy. This is consistent with the study of [32]. Humic materials are of great importance in their ability to reduce the toxic effects of other chemical elements and compounds on microorganisms [45]. Many studies indicate the ability of humic matter to inhibit the growth of pathogenic bacteria and stimulate the growth of beneficial bacteria, as increasing the concentration of humic and fulvic acids increases the activity and effectiveness of bacteria. [20] indicated that adding organic acids not only increases the number of microorganisms, but also significantly increases the activity of various enzymes, and thus increases and improves the bioenergy and enzymes in the soil

.Available nitrogen in the soil (mg.kg-1 soil(

The results of Table (5) showed that the type of irrigation water had a significant effect on the rate of available nitrogen in the soil (mg.kg-1 soil). Well water (W2) significantly excelled the other treatments and gave the highest rate of available nitrogen in the soil, reaching 54.41 mg.kg-1 soil, while mixing water (W1) gave average of available nitrogen in the soil, reaching 51.01 mg.kg-1 soil, while river water treatment (W0) recorded the lowest rate of available nitrogen in the soil, reaching 41.99 mg.kg-1 soil. The results also showed that the bio-inoculation had a significant effect on the available nitrogen in the soil. The treatment of adding Azotobacter bacteria (A1) recorded the highest rate of available nitrogen in the soil, reaching 51.66 mg.kg-1 soil, significantly excelled to the treatment without addition (A0), which recorded the lowest rate of available nitrogen in the soil, reaching 46.61 mg.kg-1 soil. As for humic acids, the results showed that adding humic acids had a significant effect on increasing available nitrogen in the soil. The treatment of adding humic acids at a concentration of 50 kg. ha-1 (H2) was significantly excelled and gave the highest rate of 51.44 mg. kg-1 soil, followed by the treatment of adding at a concentration of 25 kg. ha-1 (H1) and gave average of available nitrogen in the soil of 48.96 mg. kg-1 soil, while control treatment (H0) gave the lowest rate of available nitrogen in the soil of 47.01 mg. kg-1 soil. As for the dual interactions, the results showed that the dual interactions between the bacterial inoculum and the quality of irrigation water (W*A) had a significant effect on available nitrogen in the soil. Treatment W2A1 recorded the highest rate of available nitrogen in the soil of 56.07 mg.kg-1 soil, while the W0A0 treatment gave the lowest rate of available nitrogen in the soil, reaching 38.79 mg.kg-1 soil. The interaction treatment between irrigation water quality and humic acids W2H2 also recorded the highest rate of available nitrogen in the soil, reaching 57.15 mg.kg-1 soil, while the W0H0 treatment recorded the lowest rate of available nitrogen in the soil, reaching 40.15 mg.kg-1 soil. The interaction treatment between bacterial

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inoculum and humic acids A1H2 also significantly excelled and recorded the highest rate of available nitrogen in the soil, reaching 54.16 mg.kg-1 soil, while the A0H0 interaction treatment recorded the lowest rate of available nitrogen in the soil, reaching 44.52 mg.kg-1 soil. The data in Table (5) showed that the triple interaction between the experimental factors of irrigation water quality, bacterial inoculum and humic acids had a significant effect on the rate of available nitrogen in the soil (mg. kg-1 soil). The interaction treatment W2A1H2 significantly excelled the other interaction treatments and recorded the highest rate of available nitrogen in the soil, reaching 59.23 mg. kg-1 soil, while the treatment W0A0H0 gave the lowest rate of available nitrogen in the soil, reaching 37.48 mg. kg-1 soil.

Table (5) Effect of irrigation water quality, adding bio-inoculum, humic acids and their interaction on available nitrogen in the soil (mg. kg-1 soil(

Bacterial inoculum x Irrigation water quality) W*A(	Adding of humic acids (H(			Bacterial inoculum(A(	Irrigation water quality W
	50kg.ha-1)H2(	**25kg.ha-1)H1(**	Without adding (H0(		
38.79	41.00	37.91	37.48	Without adding (A0(	River water W0
45.18	47.69	45.02	42.82	Azotobacter bacteria (A 1)	
48.29	50.10	49.25	45.51	Without adding (A0(	Mixed water W1
53.73	55.55	53.36	52.28	Azotobacter bacteria (A1(	
52.74	55.06	52.60	50.56	Without adding (A0(	Well water W2
56.07	59.23	55.59	53.40	Azotobacter bacteria (A1(	
0.14	0.25			L.S.D 0.05	
Average Irrigation water quality(W(	Interaction between Irrigation water quality and humic acids (H*W(				
41.99	44.34	41.47	40.15	River water W0	
51.01	52.83	51.31	48.89	Mixed water W1	
54.41	57.15	54.095	51.98	Well water W2	
0.10	0.17			L.S.D 0.05	
Average Bacterial inoculum(A(	Interaction between bacterial inoculum and humic acids (H*A(				
46.61	48.72	46.59	44.52	Without adding (A0(	
51.66	54.16	51.32	49.50	Azotobacter bacteria (A1(	
0.08	0.14			L.S.D 0.05	
	51.44	48.96	47.01	Average humic acids (H(	
	0.10			L.S.D 0.05	

Available phosphorus in soil (mg.kg-1 soil(

The results of Table (6) showed that the type of irrigation water had a significant effect on the rate of available phosphorus in the soil (mg.kg-1 soil). River water (W0) was significantly excelled to the other treatments and gave the highest rate of available phosphorus after harvest, reaching 23.16 mg.kg-1 soil, while mixing water (W1) gave average of available phosphorus after harvest, reaching 17.94 mg.kg-1 soil, while well water treatment (W2) recorded the lowest rate of available phosphorus after harvest, reaching

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9.29 mg.kg-1 soil.The results also showed that the bio-inoculum had a significant effect on the available phosphorus after harvest. The treatment of adding Azotobacter bacteria (A1) recorded the highest rate of available phosphorus after harvest, reaching 18.09 mg.kg-1 soil, significantly excelled to the treatment without addition (A0), which recorded the lowest rate of available phosphorus after harvest, reaching 15.50 mg.kg-1 soil. As for humic acids, the results showed that adding humic acids had a significant effect in increasing the available phosphorus after harvest. The treatment of adding humic acids at a concentration of 50 kg. h-1 (H2) was significantly excelled and gave the highest rate of 18.16 mg. kg-1 soil, followed by the treatment of adding at a concentration of 25 kg. h-1 (H1) and gave average of available phosphorus after harvest of 17.22 mg. kg-1 soil, while control treatment (H0) gave the lowest rate of available phosphorus after harvest of 15.01 mg. kg-1 soil. As for the dual interactions, the results showed that the dual interactions between the bacterial inoculum and the quality of irrigation water (W*A) had a significant effect on the available phosphorus after harvest. The treatment W0A1 recorded the highest rate of available phosphorus after harvest of 25.35 mg.kg-1 soil, while treatment W2A0 gave the lowest rate of available phosphorus in the soil, reaching 8.93 mg.kg-1 soil. The interaction treatment between irrigation water quality and humic acids W0H2 also recorded the highest rate of available phosphorus after harvest, reaching 25.77 mg.kg-1 soil, while treatment W2H0 recorded the lowest rate of available phosphorus after harvest, reaching 8.78 mg.kg-1 soil. The interaction treatment between bacterial inoculum and humic acids A1H2 also significantly excelled and recorded the highest rate of available phosphorus after harvest, reaching 19.62 mg.kg-1 soil, while the interaction treatment A0H0 recorded the lowest rate of available phosphorus after harvest, reaching 13.96 mg.kg-1 soil. The data in Table (4) showed that the triple interaction between the experimental factors of irrigation water quality, bacterial inoculum and humic acids had a significant effect on the rate of available phosphorus in the soil (mg. kg-1 soil). The interaction treatment W0A1H2 significantly excelled the other interaction treatments and recorded the highest rate of available phosphorus after harvest, reaching 28.52 mg. kg-1 soil, while the treatment W2A0H0 gave the lowest rate of available phosphorus after harvest, reaching 8.26 mg. kg-1 soil .

Table (6) Effect of irrigation water quality, addition of bio-inoculum, humic acids and their interaction on available phosphorus in the soil (mg. kg-1 soil(

Bacterial inoculum x Irrigation water quality) W*A(	Adding of humic acids (H(			Bacterial inoculum(A(	Irrigation water quality W
	50kg.ha-1)H2(	**25kg.ha-1)H1(**	Without adding (H0(		
20.98	23.03	21.36	18.54	Without adding (A0(	River water W0
25.35	28.52	26.53	21.00	Azotobacter) A 1(	
16.60	17.56	17.14	15.08	Without adding (A0(	Mixed water W1
19.30	20.32	19.65	17.90	Azotobacter bacteria (A1(	
8.93	9.50	9.04	8.26	Without adding (A0(	Well water W2
9.64	10.02	9.61	9.29	Azotobacter bacteria (A1(	
0.08	0.14			L.S.D 0.05	

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Average Irrigation water quality(W(	Interaction between Irrigation water quality and humic acids (H*W(			
23.16	25.777	23.945	19.77	River water W0
17.94	18.938	18.395	16.49	Mixed water W1
9.29	9.76	9.325	8.775	Well water W2
0.06	0.10			L.S.D 0.05
Average Bacterial inoculum(A(	Interaction between bacterial inoculum and humic acids (H*A(			
15.50	16.70	15.85	13.96	Without adding (A0(
18.09	19.62	18.596	16.06	Azotobacter (A 1(
0.05	0.08			L.S.D 0.05
	18.16	17.22	15.01	Average humic acids (H(
	0.06			L.S.D 0.05

Available potassium in soil (mg.kg-1 soil(

The results of Table (7) showed that the type of irrigation water had a significant effect on the rate of available potassium in the soil (mg.kg-1 soil). Well water (W2) significantly excelled the other treatments and gave the highest rate of available potassium in the soil, reaching 252.958 mg.kg-1 soil, while mixing water (W1) gave average of available potassium in the soil, reaching 168.73 mg.kg-1 soil, while river water treatment (W0) recorded the lowest rate of available potassium in the soil, reaching 133.18 mg.kg-1 soil.The results also showed that the bio-inoculum had a significant effect on the available potassium in the soil. The treatment of adding Azotobacter bacteria (A1) recorded the highest rate of available potassium in the soil, reaching 197.81 mg.kg-1 soil, significantly excelled to the treatment without addition (A0), which recorded the lowest rate of available potassium in the soil, reaching 172.10 mg.kg-1 soil. As for humic acids, the results showed that adding humic acids had a significant effect on increasing the available potassium in the soil. The treatment of adding humic acids at a concentration of 50 kg. h-1 (H2) was significantly excelled and gave the highest rate of 193.33 mg. kg-1 soil, followed by the treatment of adding at a concentration of 25 kg. h-1 (H1) and gave average of available potassium in the soil of 186.68 mg. kg-1 soil, while control treatment (H0) gave the lowest rate of available potassium in the soil of 174.87 mg. kg-1 soil. As for the dual interactions, the results showed that the dual interactions between the bacterial inoculum and the quality of irrigation water (W*A) had a significant effect on the available potassium in the soil. The treatment W2A1 recorded the highest rate of available potassium in the soil of 272.46 mg.kg-1 soil, while the W0A0 treatment gave the lowest rate of available potassium in the soil, reaching 128.29 mg.kg-1 soil. The interaction treatment between irrigation water quality and humic acids W2H2 also recorded the highest rate of available potassium in the soil, reaching 269.795 mg.kg-1 soil, while the W0H0 treatment recorded the lowest rate of available potassium in the soil, reaching 130.74 mg.kg-1 soil. The interaction treatment between bacterial inoculum and humic acids A1H2 also significantly excelled and recorded the highest rate of available potassium in the soil, reaching 206.37 mg.kg-1 soil, while the A0H0 interaction treatment recorded the lowest rate of available potassium in the soil, reaching 160.60 mg.kg-1 soil. The data in Table (5) showed that the triple interaction between the experimental factors of irrigation water quality, bacterial inoculum and humic acids had a significant effect on the rate of available potassium in the soil (mg. kg-1 soil). The interaction treatment W2A1H2 significantly excelled the other interaction treatments and recorded the highest rate of available potassium in the soil, reaching 290.14 mg. kg-1 soil, while the treatment W0A0H0 gave the lowest rate of available potassium in the soil, reaching 126.08 mg. kg-1 soil .

Table (7) Effect of irrigation water quality, adding bio-inoculum, humic acids and their interaction on available potassium in the soil (mg. kg-1 soil(

Bacterial inoculum x Irrigation water quality) W*A(	Adding of humic acids (H(			Bacterial inoculum(A(	Irrigation water quality W
	50kg.ha-1)H2(	**25kg.ha-1)H1(**	Without adding (H0(		
128.29	130.63	128.16	126.08	Without adding (A0(	River water W0
138.08	140.50	138.32	135.40	Azotobacter (A 1(	
154.57	160.77	155.69	147.23	Without adding (A0(	Mixed water W1
182.89	188.46	183.30	176.91	Azotobacter bacteria (A1(	
233.45	249.45	242.41	208.50	Without adding (A0(	Well water W2
272.46	290.14	272.18	255.07	Azotobacter bacteria (A1(	
1.48	2.56			L.S.D 0.05	
Average Irrigation water quality(W(	Interaction between Irrigation water quality and humic acids (H*W(				
133.18	135.57	133.24	130.74	River water W0	
168.73	174.62	169.495	162.07	Mixed water W1	
252.958	269.795	257.295	231.785	Well water W2	
1.04	1.81			L.S.D 0.05	
Average Bacterial inoculum(A(	Interaction between bacterial inoculum and humic acids (H*A(				
172.10	180.28	175.42	160.60	Without adding (A0(	
197.81	206.37	197.93	189.13	Azotobacter bacteria (A1(	
0.85	1.48			L.S.D 0.05	
	193.33	186.68	174.87	Average humic acids (H(	
	1.04			L.S.D 0.05	

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The results of (Table 5) show a significant increase in the concentration of available nitrogen with increasing salinity of irrigation water. The reason is attributed to the fact that increasing soil salinity leads to an increase in osmotic pressure and thus reduces the plant's absorption of nitrogen, thus increasing its concentration in the soil solution. It also leads to an imbalance in the plant's absorption of nutrients, as it absorbs the ions with the highest concentration, leaving nitrogen in the soil solution, thus increasing its availability. These results are consistent with [4,9,41] who obtained an increase in nitrogen concentration with increasing salinity level. The reason for the increase in nitrogen concentration with increasing salinity level may be attributed to the fact that nitrogen is a mobile nutrient and in most cases the same amount of it is available on the root surface regardless of the salinity level and root size. The reason for the decrease in the concentration of available nitrogen in the river water treatment is due to the decrease in the salinity level, which in turn led to an increase in plant growth and nitrogen absorption due to the lack of the effect of salt stress. On the contrary, we find that at high levels of salinity, the amount of nitrogen has increased compared to the river water treatment due to the decrease in plant growth as a result of the salt effect, which was confirmed by [22]. The addition of organic humic acids (humic and fulvic) led to a significant increase in nitrogen concentration, which may be attributed to the fact that organic acids increase the biological activity in the soil to which they are added, thus increasing the ability of microorganisms to fix atmospheric nitrogen and also converting organic nitrogen into mineral. [42] also reached results indicating an increase in the percentage of soil nitrogen with increasing the added amounts of humic acid, while[17] when they added humic acid at different levels to a saline soil, it gave a significant increase in the amount of available nitrogen in the soil for all addition levels. [11] also obtained similar results to the above, as the amount of available nitrogen in the soil increased when they planted wheat in the field, and this was due to the addition of different levels of humic acid. The addition of humic acid led to an increase in the branches and ramifications of the roots, and thus an increase in the absorption of nutrients by the roots in the soil and the secretion of organic acids from the roots, which in turn reduces the soil pH, which increases the availability of nutrients [31.[

The increase in available nitrogen in the soil is due to the addition of humic acids, which have direct effects on the availability of nitrogen through its nitrogen content and the release of its available forms in the soil [3]. Humic acid also contributes to improving the chemical properties of the soil, in addition to its nutrient content, it increases the availability of nutrients, including nitrogen in the soil. These results are consistent with what was found by[1,2 . [

The increase in available nitrogen in the soil when using the bacterial bio-inoculum (Azotobacter) is attributed to the fact that bacteria fix atmospheric nitrogen, and these results are consistent with what was obtained by [35]. The significant increase in the amount of nitrogen available in the soil in the inoculated treatments is due to the increase in the amount of nitrogen fixed by bacteria capable of fixing nitrogen, especially Azotobacter bacteria, which have high efficiency in this process. These results are consistent with what was found by [14] that the products of organic fertilizer decomposition, such as amino and organic

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acids, work to increase the availability of nitrogen in the rhizosphere region, and this increases the activity of organisms in the soil, including nitrogen-fixing organisms, and this is consistent with what was found by [23]). The results of (Table 4) also show a significant effect of irrigation water salinity on the concentration of available phosphorus in the soil. The reason for the decrease in phosphorus availability with increasing irrigation water salinity can be attributed to the availability of ions that bind with phosphate, such as calcium ions, and their precipitation and conversion into forms that are not available to the plant. The results are in the same direction as what was obtained by [8]. These results also agree with what was found by[4,18,28] in that the decrease in the concentration of available phosphorus with increasing the salinity level of irrigation water is attributed to the competition between chloride and phosphorus when the concentration of chloride in the soil solution increases due to the saline conditions of the soil.

The role of organic acids in reducing the adsorption of added phosphorus present in the soil, as well as forming chelating compounds that protect it from fixation, as well as the direct effects represented by dissolving compounds containing phosphorus or dissolving primary minerals in which phosphorus is included, may be attributed to the fact that organic fertilizer increases the cation exchange capacity and the association with dissolved ions to form compounds that are easy to wash, and also the organic acids produced from organic fertilizer have a role in dissolving compounds that contain potassium in their composition, and these results are consistent with what was described[23,29] . The bio-inoculation with azotobacter led to the moral superiority of phosphorus concentration. The reason for the increase in the concentration of the element in the soil may be attributed to its role in secreting some enzymes and organic acids [that work to reduce the electrical conductivity and the degree of soil reaction and increase the availability of elements in the soil as a result of the increased activity of bacteria that fix atmospheric nitrogen and dissolve phosphorus and potassium compounds by organic acids. These results are consistent with [12] if they mentioned that adding bio-fertilizers leads to an increase in some nutrients (nitrogen, phosphorus and potassium). As for the moral effect in (Table 5) of the salinity of irrigation water in increasing the concentration of available potassium in the soil, the reason for the increase in the concentration of potassium ion when using well water is attributed to the increase in the concentration of sodium ion in that water, which increased its concentration in the soil solution, which negatively affected the absorption of potassium by the plant due to the competition of sodium ions with potassium ions on the absorption sites by the plant roots, and then its concentration increased in the soil solution. This result is consistent with what was obtained by [6]. The increase in the salinity of irrigation water leads to an increase in soil salinity, which leads to an increase in osmotic pressure and thus reduces the availability of nutrients and leads to an imbalance in the absorption of nutrients by the plant, [14], The increase in soil salinity leads to a decrease in the concentration of available potassium in the soil as a result of the increase in dissolved ions in the soil solution and the difference in the ionic balance in the soil, As for the effect of humic acids in increasing the availability of potassium in the soil, it may be due to the ability of humic acids to increase

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the root system to create a balance in the size of the vegetative system, which increased significantly as a result of the addition of humic acids. These roots work to secrete organic acids that work to dissolve some potassium-bearing compounds and release them, thus increasing their availability [14,42] . Organic acids also play a role in dissolving compounds that contain potassium in their composition, and these results are consistent with what was found by[23, 29 [

As for the effect of the bacterial bio-inoculum on the concentration of available potassium in the soil, the addition of the bio-inoculum had a significant effect in increasing the available potassium in the soil. The reason for this can be attributed to the fact that microorganisms help in increasing the availability of potassium and preserving it from fixation and loss processes through the secretion of enzymes and organic acids [27] These results are consistent with [12.[

References

.1 Al-Ani, Ahmed Salman Hamad. 2018. The effect of humic acid and nitrogenous bacterial biofertilizer on the availability of some nutrients and the growth and yield of yellow corn (Zea mays L.). PhD theses. College of Agriculture. University of Baghdad.

.2 Al-Barakat, Hanoon Nahi Kazim. 2016. Effect of biofertilization and methods of adding humic and fulvic acids on the availability of NPK, iron and zinc in the soil and the productivity of yellow corn (Zea mays L.), PhD thesis, University of Baghdad.

.3 Al-Furaiji, Hussein Taha Radhi. (2019). Adding calcium carbide, humic acid and nitrogen to the soil and its effect on the growth and yield of sunflower (Helianthus annuus L.). Master's thesis. Department of Soil Sciences and Water Resources. College of Agricultural Engineering Sciences. University of Baghdad .

.4 Al-Hamdani, Fawzi Mohsen. (2000 Salman Saleh The interaction between salinity of irrigation water and phosphate fertilizer and its relationship to some chemical characteristics and wheat plant yield. PhD thesis. College of Agriculture, University of Baghdad

.5 Ali, M. H. 2011. Practices of Irrigation & On-farm Water Management: Volume 2.Springer New York Dordrecht Heidelberg London

.6 Al-Mamouri, Abdul-Baqi Dawood Salman. 2004. Effect of phosphate fertilizer, soil texture and irrigation water source on some chemical and fertility properties of the soil and growth of wheat plant. Master's thesis, College of Agriculture, University of Baghdad.

.7 Al-Tahir, Faisal Mahbas Madlul. 2005. The effect of foliar feeding with iron, zinc and potassium on the growth and yield of wheat Triticum aestivum L.. PhD thesis, College of Agriculture - University of Baghdad.

.8 Al-Zaidi, Hatem Saloum Saleh .. 2011 The interaction effect of irrigation water quality and organic and phosphate fertilizers on the growth and yield of cauliflower (Brassica oleracea var. botrytis). Master's thesis. Department of Soil Sciences and Water Resources. College of Agriculture. University of Baghdad. Iraq.

.9 Al-Zubaidi,A.S,;Aljanabi, and A.Alrawi.1990.Interaction between nitrogen and phosphorus fertilizers soil salinity and its effect on growth and composition of corn.N.El

Bassam et al.(Eds.)Genetic aspects of plant mineral nutrition,195-202.

.10 Amadi, Tariq and Abdul Karim Jadou and Iman Mahdi Aliwi, 1996. Evaluation of the water quality of Saddam River in the northern and central sector, Journal of Agricultural and Iraqi Sciences, Volume 27, Issue 1.

.11 Arjumend, Tuba, M. Kaleem Abbasi, and Ejaz Rafique.(2015). Efeects of Lignite-Derived Humic acid on some selected soil properties, growth and nutrient uptake of wheat (Triticum Aestivum L.) grown under greenhouse conditions. Pakistan Journal of Botany 47.6 : 2231-2238.

.12 Arti , S. Shanware ; Surekha , A. Kalkar , and Minal , M. Trivedi (2014). Potassium solubilizser : occurrence , mechanism and their role as competent biofertilizers. International J. of Current Microbiology and applied sciences. ISSN. 3(9): 622-629.

.13 Ashraf, M. A. ; Rasool, M. & Mirza, M.S. (2011).Nitrogen fixation and indole acetic acid potential of bacteria isolated from rhizosphere of sugarcane (Saccharum officinarum L.).Adv. in Biol. Res.,5(6):348-355

.14 Chen, Y. and T. Aviad . (1990). Effects of Humic substances on plant growth In MacCarthy, C.E. Clapp,R.L.Malcolmy,and P.R. Bloom(eds) Humic substances in soil and crop sciences.Selected Readings. Soil Sci. Soc. Am. Madison , Wisconsin , USA , pp: 161-186.

.15 Choudhary, O. P., S. R, Grattan. and P. S, Minhas. 2011.Sustainable Crop Production using Saline and Sodic Irrigation Waters. Springer Science+Business Media B.V.

.16 Datta, J.K., A. Banerjee1, M. Saha Sikdar, S. Gupta and N.K. Mondal.2009. Impact of combined exposure of chemical, fertilizer, bio-fertilizer and compost on growth, physiology and productivity of Brassica campestris in old alluvial soil. Journal of Environmental Biology.30(5): 797-800.

.17 El-Galad, M. A.; Dalia A. Sayed and Rania M. El-Shal .(2013). Effect of humic acid and compost applied alone or in combination with Sulphur on soil fertility and Faba bean Productivtiy under saline soil conditions. J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 4 (10): 1139 - 1157,

.18 Fakira,A.B.A:1996.Effect of water and salinity stresses on summer forage crops.Athesis-crop science-Faculty of Agric-Alexandria Uni

.19 FAO Aquastat Glossary.2022: http://www.fao.org/nr/water/aquastat/ data/glossary/search.html?lang=en (last access .(

.20 Freitas, A.D. and N.P. Stamford(2002). Associative nitrogen fixation and growth of maize in a Brazilian rainforest soil as affected by Azospirillum and organic materials. Tropical Grasslands . 36: 77–82.

.21 Gahlaut, V.,V. Jaiswal., B.Tyagi., G.Singh., S.Sareen.HS., Balyan and Gupta, PK. 2017. QTL mapping for nine drought-responsive agronomic traits in bread wheat under irrigated and rain-fed environments. PLoS ONE 12:e0182857

.22 Hassan, Zainab Kazim and Abdul Mahdi Saleh Al-Ansari. (2016). The effect of inoculation with single and double biofertilizers on the growth of yellow corn and its absorption of nitrogen and phosphorus in sandy soil affected by salinity. Basra Journal of Agricultural Sciences, Vol. 29(2), 367-379.

.23 Ibrahim, Waldan Ali Abdul Amir. 2019. Effect of mineral and organic fertilization and spraying with (humic acids and trace elements) on the availability of N, P

ISSN 2072-3857

and K in the soil and on the growth and yield of yellow corn (Zea mays L). Master's thesis. College of Agricultural Engineering Sciences. University of Baghdad.

.24 Islam, M. R., M. B, Hossain., A. B, Siddique., M. T, Rahman. and M, Malika. 2014. Contribution of green manure incorporation in combination with nitrogen fertilizer in rice production.SAARC J. Agri., 12(2): 134-142.

.25 Jadoua, Khadir Abbas. 1995. Wheat Facts and Guidelines. Publications of the Ministry of Agriculture. General Authority for Agricultural Guidance and Cooperation.

.26 Kaymakanova, M., N. Stoeva, and T. Mincheva. 2008. Salinity and its effects on the physiological response of bean (Phaseolus vulgaris L.). Journal of Central European Agriculture, 9(4):749-755.

.27 Khan, V.M. ; K.S. Manohar ; S.K. Kumawat , and H.P. Verma . (2013). Effect of Vermicompost and biofertilizers on yield and soil nutrient status after harvest of cowpea (Vigana unguical ata L.) J Trace Elem Med. Biol. 18:355-364 USA.

.28 Langdale, G.W.;J.R.Thomas and T.G. Littleton,1973.Nitrogen metabolism of stargrass as affected by nitrogen and salinity.Agron.J.65:468-470.

.29 Mazid, Ahmed Hamid. 2020. The effect of inoculation with two local isolates of Paenibacillus Polymyxa bacteria and levels of organic matter on NPK readiness, growth and productivity of yellow corn (Zea mays L). Master's thesis. College of Agriculture, Al-Muthanna University

.30 Mdluli,S.Y. 2018 . Characterisation of Selected Bread Wheat (Triticum aestivum L.) Genotypes for Drought Tolerance Based on SSR Markers, Morphophysiological Traits and Drought Indices. Master of Science in Plant Breeding.School of Agricultural, Earth and Environmental Sciences College of Agriculture, Engineering and Sciences University of KwaZulu-Natal Pietermaritzburg Republic of South Africa.

.31 Mora,V.,Bacaicoa,E.,baigorri,R.,Zamarreno,A.M.,and Garcia-Mina, J.M .2014. No and IAA key regulators in the growth promoting action of humic acid Cucumis Sativusl.J.Plant growth Regul.33(2):430-439.

.32 Murmu,K.; D. K.Swain and B. C. Ghosh(2013). Comparative assessment of conventional and organic nutrient management on crop growth and yield and soil fertility in tomato-sweet corn production system.Australian Journal of Crop Science. 7(11): 1617-1626.

.33 Nawadkar, R.B., Jadhav, D. B. & Shaikh, N.R.(2015).Isolation of Azotobacter spp. from saline soil and its application on wheat (Tritium aestivum) plant for future use in reclamation of saline soil with wheat plant. Res. J. of Life Sci. Bioinformatics Pharmaceutical and Chem. Sci., 1(2):62-73.

.34 Omer,A.M.;Emara,H.M.;Azoghlout, R.; Abdel. R.; Momen ,M.O.& Dawwan, G.H.(2016). Potential of Azotobacter salinesris as plant growth promoting rhizobacteria under saline stress conditions. Res. J. of pharmaceutical, Biol. and Chem. Sci.,7(6):2572-2582

.35 Oster , J.D. and S.R. Grattan . 2002. Drainage water reuse. Irrigation and Drainage Systems. 16 : 297-310.

.36 Page, A. L. ; Miller, R.H. and Keeney , D. R. (1982). Methods of soil analysis . Part2 . chemical and Microbiological Properties . 2nd . ed. . am. Soc. Agron. , Inc., Soil Sci. Soc. Am. , Inc. Madison , Wisconsin. U.S.A.

ISSN 2072-3857

.37 Prior,B.A., C.P.Kenyon ; M.V.Veen and J.P. Mildenhall. 1987. Water relations of solute accumulation in Pseudomonas fluorescens. J. of Appl. Bacter. 62 : 119-12

.38 Qadir, M. ;Ghafoor, A. &Mustafa ,G.(2000).Amelioration strategies for saline soils :areview land Degrad .Dev.,11:501-521.

.39 Rana, R. ; Ramesh; and P. Kapoor(2013). Biofertilizers and Their Role in Agriculture. Popular Kheti.1(1). www.popularkheti.com.

.40 Shin, W. ;Siddikee, M.M.; Joe, B. A.;Selvakumar,G.;Kany ,Y.;Jeo ,S., Samaaddar, S.; Chatterjee, P.; Walitang ,D.; Canratana ,M. & Sa, T. (2016). Haloterlant plant growth promoting bacteria mediated salinity stress ameliorate in plant .Korean J. Soil Sci.Fert.,49(4):355-367.

.41 Shukri, Hussein Mahmoud. 2002. The effect of using saline water alternately and mixed on wheat growth and salt accumulation in the soil. PhD thesis. College of Agriculture - University of Baghdad, p. 1

.

.42 Song S.; P. Lehne; J. Le; T. Ge and D. Huang, (2010). Yield,fruit, quality andnitrogen uptake of organically and conventionally grown muskmelonwith different inputs of nitrogen, phosphorus and potassium J. of Plant Nutrition. 33: 130-141.

.43 Tan, H. Kim. (2003). Humic Matter in Soil and the Environment Principles and Controversies. Library of Congress Cataloging-in-Publication Data. New York,

.44 Walpola, B. C., and K. K. I. U. Arunakumara. 2010. Effect of salt stress on decomposition of organic matter and nitrogen mineralization in animal manure amended soils. The Journal of Agricultural Sciences. 5 (1): 9-18 .

.45 Wang , S,. and C., N., Mulligan.)2009(. Enhanced Mobilization of arsenic and heavy metals from mine tailings by humic acid. Chemosphere.74:274–279.

.46 Zahran, H. H. 1997. Diversity adaptation and activity of the bacterial flora in saline environments. Biol. Fertil. Soils. 25: 211-223

ISSN 2072-3857