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Effect of organic matter and ionic strength and soil texture on positive ions in the soil *extracted search

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Abstract:
The overall concentration of mineral salts in the water extracted from the soil is referred to as salinity, and an increase in salinity presents a problem for the plant. The salt buildup in the ground can be traced back to a few different sources (groundwater, irrigation water, and unfair agricultural practices resulting from man from excessive chemical fertilization). Because it disperses soil particles and aggregates, which causes a decrease in water conductivity, poor aeration, and an increase in the bulk density of the soil, the sodium ion is considered one of the essential and dependent ions in the process of determining the quality of irrigation water. This is due to its effect on chemical properties, as an increase in its concentration in irrigation water directly affects salinity. In addition, the sodium ion's effect on some of the soil's physical The soil's interaction with other ions, such as chlorides, carbonates, and bicarbonates, results in the formation of a variety of salt compounds, all of which contribute to the process of salinizing the soil. Therefore, the research assumes that washing the soil or using organic conditioners will minimize the number of salts and sodium in the soil (organic matter). In addition, the significance of incorporating organic matter into the soil in order to boost output while simultaneously enhancing the soil's physical and chemical characteristics The purpose of this research is to investigate the factors that influence the total number of positively charged ions in the soil, including ionic strength, soil texture, and organic matter.

Keyword:

Research problem:-
The high quantities of salts in the soil in the Iraqi lands due to the scarcity of water led to a reduction in production.

Research hypothesis:
The research hypothesis states that the percentage of salts in the soil is reduced, and the percentage of sodium in the soil that leads to the dispersion of soil particles is reduced through washing the soil or using organic conditioners (organic matter).

Research importance:-
The significance of incorporating organic matter into the soil to enhance both the soil's physical and chemical characteristics, the level of production, and the effect that the soil's texture has on the quantities of beneficial chemical elements present in the soil.

Research goal:
This research aims to investigate the role that ionic strength, soil texture, and organic matter play in determining the total number of positively charged ions that are dissolved in the soil.

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Introduction:

The total concentration of mineral salts in the soil water extract is what we mean when we talk about salinity (Al-Abed & Boudurban, 2016). According to the components in the soil that contributed to its formation, the level of salt in the ground was categorized as either primary or secondary. Natural primary salinity is produced when salts accumulate in the soil or groundwater over an extended period due to one of two processes. There are two natural processes; the first strips the primary resources that contain soluble salts, especially calcium, magnesium, and sodium chlorides, and to a lesser extent, their carbonates and sulfates. In contrast, the second natural process works to precipitate salts carried by wind and rain from the oceans (Al-Wahaibi, 2009). Soil is a mixture of ions of chlorides, carbonates, bicarbonates, sulfates, sodium, calcium, magnesium, etc., and it may be found dissolved as chlorides and others (Al-Jaafar, 2014). Among the most salts that cause the problem of salinity are sulfates and chlorides of sodium and magnesium, in addition to other salts, and the sodium ion is the most important of these. The problem is that large concentrations of it reduce the yield of many crops, such as wheat and economically significant barley (Tester & Munns, 2008).

The increase in salinity is a challenge for the plant. The salinity accumulation of the soil gets from several sources (groundwater, irrigation water, wrong agricultural practices as a result of human excessive chemical fertilization (Rajendran et al., 2022) and Sodium ion is considered one of the essential and approved ions in determining the quality of the irrigation water, due to its effect on some physical properties of the soil, as it disperses soil particles and aggregates, which causes a decrease in water conductivity, poor aeration, and an increase in the bulk density of the soil, in addition to its effect on the chemical properties, as it increases its concentration In irrigation water, it directly affects soil salinity through its association with some other ions such as chloride, carbonate, and bicarbonate, and they form different salt compounds that work on soil salinity (Follett & Saltanpour, 2001).

Glover (1996) indicated that water containing high concentrations of calcium and magnesium ions is a new characteristic of water, as they work to improve the chemical properties of soil by reducing the effect of sodium ion when irrigating with that water. Abboud (2013) noticed that an increase in the ratio of magnesium to calcium in irrigation water led to an increase in soil salinity and the proportion of adsorbed sodium.

Materials and Methods:

A potting experiment was conducted in the fields of the " College of Agriculture - the University of Wasit" for the fall agricultural season (2021-2022) using two types of soils of different textures; the first is loamy silt (T1) brought from Kardiya district - Wasit and the second texture is mixed, and sandy (T2) brought from river banks. Moreover, for a depth of 0-30 cm, the soils were classified according to the modern American classification as sedimentary soils classified to a level below the great aggregates within the order (Typic-Torrifluvent) according to what was stated in (2006 Soil Survey Staff,) Soil samples were brought before planting for analysis. Table (1) shows some of these soils physical characteristics and chemical properties. Air dried and ground with a wooden hammer, sifted through a sieve with a hole diameter of 4 mm, and used plastic pots with a diameter of (25 cm) , a base of (17 cm), and a height of (23 cm). A layer of glass wool and gravel was placed at the bottom, and the pots were filled with soil at a rate of (10kg) for all treatments.

Table (1) Some physical properties, and chemical properties of the study soil.

Unit	the value		Adjective
	soil (river banks) T_2	(Kardiyah soil) T_1	
-	7.47	7.35	Soil reaction pH 1:1
Ds Siemens M^{-1}	361.	621.	Electrical conductivity EC 1:1

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<table>
<tr><td>Centimol of charge kg⁻¹ soil</td><td>18.54</td><td>25.25</td><td colspan="2">Exchange capacity of positive ions CEC</td></tr>
<tr><td rowspan="2">g/kg⁻¹ soil</td><td>0.5</td><td>0.75</td><td colspan="2">Soil organic matter</td></tr>
<tr><td>0.01</td><td>0.025</td><td colspan="2">gypsum</td></tr>
<tr><td rowspan="8">mmol L⁻¹</td><td>3.7</td><td>4.3</td><td colspan="2">Calcium Ca⁺²</td></tr>
<tr><td>1.6</td><td>2.2</td><td colspan="2">Magnesium Mg⁺²</td></tr>
<tr><td>1.7</td><td>2</td><td colspan="2">Sodium Na⁺</td></tr>
<tr><td>1.1</td><td>1.4</td><td colspan="2">Potassium K⁺</td></tr>
<tr><td>Nil</td><td>Nil</td><td colspan="2">Carbonate CO₃⁻²</td></tr>
<tr><td>301.</td><td>1.60</td><td colspan="2">Bicarbonate HCO₃⁻</td></tr>
<tr><td>2.80</td><td>3.40</td><td colspan="2">Sulfate SO₄⁻²</td></tr>
<tr><td>6.40</td><td>8.50</td><td colspan="2">Cl⁻</td></tr>
<tr><td rowspan="3">mg kg⁻¹ soil</td><td>20.5</td><td>29</td><td colspan="2">ready nitrogen</td></tr>
<tr><td>9.2</td><td>10</td><td colspan="2">ready phosphorous</td></tr>
<tr><td>75.45</td><td>88.93</td><td colspan="2">Ready Potassium</td></tr>
<tr><td rowspan="2">cm³ cm⁻³</td><td>0.22</td><td>0.264</td><td colspan="2">field capacitance</td></tr>
<tr><td>0.085</td><td>170.1</td><td colspan="2">wilting point</td></tr>
<tr><td rowspan="3">gm kg⁻¹</td><td>75</td><td>45</td><td>the sand</td><td rowspan="3">Minute volume analysis</td></tr>
<tr><td>15</td><td>15</td><td>silt</td></tr>
<tr><td>10</td><td>40</td><td>slurry</td></tr>
<tr><td></td><td>Loamy Sand</td><td>Salty Clay</td><td colspan="2">tissue</td></tr>
</table>

" The soil was fertilized by adding nitrogen 200 kg N ha^{-1} in the form of urea (N 46%) in two batches, and the first at planting and the second 45 days after adding the first batch with irrigation water. Phosphate fertilizer (triple superphosphate) P 20% at a rate of 80 was also added (80 Kg P ha^{-1}) at once, mixed with soil, when planting, and the potassium fertilizer was added at a level of (120 kg K ha^{-1}) in the form of potassium sulfate (41.5% K), mixed with the soil when planting according to the fertilizer recommendation" (Al-Tamimi et al., 2014) .

Wheat seeds (IBA 99 variety), prepared by the Seed Inspection and Certification Department, Wasit Branch / Ministry of Agriculture, were sown in plastic pots on 11/24/2021, with 10 seeds per pot, taking into account the selection of grains of comparable size and soundness. After that, they were reduced to 6 plants in each pot on a date. 12/28/2022 Weeds were removed manually, and all the pots were covered with a (nylon) cover to protect them from rainwater during germination. In the maturity stage, all the pots were covered with a net to keep the grains from attacking birds.

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In the process of irrigating the plants, tap water was used. Irrigation was carried out to reach the field capacity of fifty percent of the available water throughout plant growth. This was accomplished by weighing the pot containing the soil and, the plant , then adding water to the plants as required based on the amount of available water that had been lost using the gravimetric method.

Experiment design :-

A factorial experiment was conducted using a completely randomized design (CRD) and included 48 experimental units resulting from the agreement of three factors, namely:
1- The ionic strength is denoted by F1, F2, and F3
2- Soil texture, symbolized by T1 and T2
3- Humic acid, symbolized by M0 and M1
4- Four repetitions, denoted by R1, R2, R3, and R4
Thus, the number of experimental units = (3 * 2 * 2 * 4) = 48

Soil physical and chemical analyzes:

Chemical analyzes were carried out according to Bashour and Al-Sayegh (2007):

1. The degree of soil reaction (pH) was estimated in a soil: water extract (1:1) using a pH-meter.
2. The electrical conductivity (EC) was estimated in a soil: water extract (1:1) using the EC-meter.
3. " The exchange capacity of positive ions (CEC), was estimated by using sodium acetate solution (1M) at a reaction temperature of 8.2 as a saturated solution and ammonium acetate solution (1M) at a reaction temperature of 7 as a displacer solution and measuring the sodium with a flame photometer as stated in USDA ." (USDA, 1954)
4. The dissolved positive ions (Ca^{+2}, Mg^{+2}, Na^{+}, and K^{+}) were estimated in a 1:1 extract. Ca^{+2} and Mg^{+2} were estimated using the leaching method using EDTA Na_2, and the dissolved K^{+} and Na^{+} were estimated using a flame-measuring device.
5. Carbonates and bicarbonates were estimated by titration with (H_2SO_4) (N 0.01).
6. Chloride was measured by leaching with silver nitrate (N 0.05).
7. Sulfate by muddying using barium chloride.
8. "Gypsum was determined by the acetone precipitation method (Page et al., 1982)".
9. "The organic matter was estimated by the wet digestion method according to the method of Walkly and Black mentioned in (Page et al., 1982)".
10. "The available nitrogen was estimated using the micro Kjeldahl apparatus, according to the Bremner method mentioned in (Page et al., 1982)".
11. "Ready Phosphorus: Ready phosphorus was extracted from the soil using a sodium bicarbonate solution (0.5 M), and according to the Olsen method, then the color was developed with ascorbic acid, and the phosphorus was estimated using a spectrophotometer at a wavelength of (882 nm) according to the Watanabe and Olsen method mentioned in Page et al. (1982)".
12. "The prepared potassium was extracted by ammonium acetate ($_1$N NH_4) (OAC) (pH = 7), then estimated using a flame photometer (Black et al., 1965)".
13. "Estimating the volumetric distribution of soil particles by the hydrometer method (Bouyoucos, 1962)".
14. "The field capacity was estimated at tensile (33 kPa) , according to the method presented by black (Black et al., 1965)" .
15. "The permanent wilting point was estimated at (1500) kPa tension, according to the method presented by black (Black et al., 1965)" .

Results and discussion

➢ **Calcium (Ca^{+2}) :-**

The findings are summarized in Table 2, which presents information regarding the effect of organic matter, ionic strength, and soil texture on the concentration of dissolved calcium ions in the soil solution at the harvesting stage. 6.63 mmol L^{-1} at the levels of M0 and M1 addition. The reason for the low concentration of dissolved calcium ions in the soil when treated with organic fertilizers is due to the role of organic matter in improving the chemical properties of the soil as it acts as a chemical reformer where humic acids contribute

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to the chelation of dissolved ions and form more soluble compounds. In the soil solution, which facilitates its washing and movement with irrigation water, as well as the part that organic matter plays in enhancing the soil's physical properties—namely, its structure, permeability, and the rate at which it washes away—which, in turn, results in a reduction in the amount of salt that is accumulated in the soil. The results demonstrated that there was a substantial relationship between the ionic strength and the calcium ion concentration, as shown by the fact that the concentration was at its maximum in treatment F3, followed by F2 and F1, as it reached 10.93, 6.83, and 3.63 mmol L^{-1}, respectively. This increase was directly proportional to the levels of soil salinization, which is consistent with With Al-Mamouri (2004) and Al-Zaidi (2011), who indicated an increase in the concentration of calcium ions in the soil with an increase in its salinity.

The analysis showed a significant effect of the soil texture on the concentration of calcium ions at the harvesting stage, as the results showed significant differences between the treatments, as the silty clay texture (T1) gave the highest value, reaching 7.80 mmol l^{-1}. The sandy mixture texture (T2) gave 6.46 mmol l^{-1}; This may be attributed to the effect of the surface area of the silty clay soil tissue due to the increase in its content of clay and its ability to hold positive ions, including the calcium ion, and the increase in its liberation in the soil solution. “This result is consistent with Shukri (2002) and (Ahmed et al. (2006)”.

The results of the intervention between the soil texture and the ionic strength indicated that there were significant differences, as the highest value in the combination F3T1 reached 11.85 mmol L^{-1} and the lowest value amounted to 3.29 mmol L^{-1} in the combination F1T2 due to the difference in soil textures and the difference in ionic strength between the combinations.

Table 2. Dissolved calcium ion concentration (mmol L^{-1}) in the soil for the harvesting stage.

F * T		**humic acid (M)**		**Soil tissue**	**ionic**
		M1	**M0**	**(T)**	**(F)**
	3.97	**3.63**	**4.31**	**T1**	**F1**
	3.29	**2.47**	**4.12**	**T2**	
	7.57	**7.00**	**8.14**	**T1**	**F2**
	6.08	**5.41**	**6.75**	**T2**	
	11.85	**11.55**	**12.15**	**T1**	**F3**
	10.00	**9.75**	**10.25**	**T2**	
0.030	**LSD F*T**		**0.042**	**LSD F*T*M**	
	F			**F * M**	
	average ionic strength	**M1**	**M0**	**ionic strength**	
	3.63	**3.05**	**4.21**	**F1**	
	6.83	**6.21**	**7.45**	**F2**	
	10.93	**10.65**	**11.20**	**F3**	
0.021	**LSD F**		**0.030**	**LSD F* M**	
	M			**T * M**	
	average soil tissue	**M1**	**M0**	**Soil tissue**	
	7.80	**7.39**	**8.20**	**T1**	
	6.46	**5.88**	**7.04**	**T2**	
0.017	**LSD T**		**0.024**	**LSD T*M**	

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			M
	M1	M0	humic acid
	6.63	7.62	humic acid average
	0.017		LSD M

Source: - Prepared by the researcher

The results also indicated significant differences between the interactions resulting from the ionic strength and the organic matter, as the highest value was 11.20 mmol L^{-1} in the combination F3M0 and the lowest value in the combination F1M1 to 3.05 mmol L^{-1}. Soil and its role in improving soil chemical properties by increasing cation exchange capacity and regulatory capacity in soil TAN (2003).

The interaction between soil tissue and organic matter showed a significant effect, as the highest value in the combination (T1M0) was 8.20 mmol L^{-1}, and the lowest value was 5.88 mmol L^{-1} in the combination T2M1. This is due to the difference in soil textures, the addition of organic matter to the soil, and its role in Improving different soil properties.

The resulting combination of ionic strength, the addition of humic acid, and soil texture showed a significant effect on the calcium ion concentration for the harvesting stage, as the highest value in the combination (F3T1M0) was 12.15, while the lowest value in the combination (F1T2M1) was 2.47.

- **Magnesium (Mg^{+2}) :**

The results in Table 3 showed the effect of organic matter, soil tissue, and the ionic strength of the soil solution on the concentration of dissolved magnesium ions in the soil solution for the harvesting stage. Soil 5.15 and 4.43 mmol L^{-1} for M0 and M1 levels, respectively. The reason for the decrease in the values of the dissolved magnesium ion concentration in the soil when treated with organic fertilizers may be attributed to the role of organic matter as a chemical reformer to improve the chemical properties of the soil, as humic acids contribute to increasing the chelation of dissolved ions And the formation of compounds that are more soluble and widespread in the soil solution, which facilitates their movement and leaching with irrigation water, as well as its role in improving the physical properties of the soil, and then improving the structure and permeability of the soil and increasing the leaching speed in it, which reduces the accumulation of salts in the soil.

The ionic strength of the solution, greatly impacted the concentration of magnesium ions. The ionic strength of the soil solution was directly correlated with the rise in magnesium concentration. There were substantial disparities between the various therapies, as the highest value reached 7.42 mmol L^{-1} in treatment F3 and the lowest value at F1 amounted to 2.38 mmol L^{-1}. This increase was direct. Salting levels are attributed to salts' role, especially monomers such as sodium chloride salt resulting from saline irrigation water, in dissolving carbonate minerals, which results in the liberation of calcium and magnesium (Al-Obaidi et al., 2012 and Al-Kiki, 2013).

Table 3. Dissolved magnesium ion concentration (mmol L^{-1}) in the soil for the harvesting stage.

F * T	Humic Acid (M)		Soil	Ionic
	M1	M0	(T)	(F)
2.80	2.45	3.15	T1	F1
1.96	1.87	2.05	T2	
5.42	5.29	5.54	T1	F2
3.73	3.43	4.03	T2	
7.68	6.55	8.80	T1	F3
7.16	7.00	7.31	T2	

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N.S	LSD F*T	N.S		LSD F*T*M
F		F * M		
The average ionic strength		M1	M0	Ionic strength
2.38		2.16	2.60	F1
4.57		4.36	4.79	F2
7.42		6.78	8.06	F3
0.507	LSD F	N.S		LSD F* M
T		T * M		
The average soil texture		M1	M0	soil texture
5.30		4.76	5.83	T1
4.28		4.10	4.46	T2
0.414	LSD T	N.S		LSD T*M
M				
		M1	M0	Humic acid (M)
		4.43	5.15	Humic acid average (M)
		0.414		LSD M

Source: - Prepared by the researcher

The study found a substantial difference between the treatments, which indicated a considerable effect that the soiled tissue had on the concentration of magnesium ions. It reached its maximum point in T1, reaching 5.30, and in T2, reaching 4.28 mmol L^{-1}. The increase in this value may be attributed to the increase in the surface area of this tissue (clay placer) and the increase in its content of carbonate minerals and clay. Then the increase in the magnesium ion's holding leads to an increase in the concentration of this ion in the soil and its liberation in the soil solution upon extraction. This result agrees with what was obtained by Al-Maamouri (2004) and Ahmed and others (2006).

While the statistical analysis did not show significant differences in the levels of ionic strength in their interactions with the levels of added organic matter or soil tissue, there was no significant effect of interaction between organic matter and soil tissue.

The resulting combination of ionic strength, the addition of humic acid, and soil texture showed no significant effect on the magnesium ion concentration for the harvesting stage, as it reached the highest value in treatment F3T1M0, reaching 8.80, while the lowest value was in treatment F1T2M1, amounting to 1.87.

➢ **Sodium Na^{+1}:**

The findings presented in Table 4 illustrated how the concentration of dissolved sodium ions in the soil solution changed due to the presence of organic matter, soil tissue, and the ionic strength of the soil solution at the time of harvesting. The dissolved sodium ion in the soil was 10.63 and 9.18 mmol L^{-1} at the M0 and M1 levels, respectively. The decrease in the dissolved sodium ion concentration in the soil when treated with organic fertilizers is attributed to the role of organic matter as a chemical reformer to improve soil properties and its role in improving soil properties. Soil is physical and then improves soil structure and permeability and increases the leaching rate, which leads to the movement of sodium ions downward with irrigation water away from the root zone (Al-Touqi, 1999).

The results showed significant effect of ionic strength on sodium ion concentration. This was because the concentration of the dissolved sodium ion increased with the ionic strength of the soil solution; additionally, there were significant differences between the treatments. F3, F2, and F1, respectively, and the increase was direct with the levels of soil salinization, which is due to the salinization of the soil with levels of saline water. There was no soil leaching due to irrigation to 50% of the available water throughout plant growth.

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The soil texture affected the sodium ion concentration in the According to the findings, the texture of the soil had a discernible impact on the number of sodium ions in the sample, as the highest value was in T1 and then in T2, reaching 12.9 and 7.62 mmol L^{-1}, respectively. This may be due to the increase in surface area in the soil. Alluvial clay tissue increases its clay content and positive holding ions, then increase the concentration of sodium ions in the soil and releases it to the soil solution upon extraction. This result is consistent with what was obtained by Al-Mamouri (2004), Ahmed et al. (2006), and Al-Azzawi (2018).

Table 4. Dissolved sodium ion concentration (mmol L^{-1}) in the soil for the harvesting stage.

F * T		Humic Acid (M)		soil texture	Ionic strength
		M1	M0	(T)	(F)
9.45		7.52	11.38	T1	F1
3.46		3.30	3.61	T2	
12.49		12.12	12.87	T1	F2
8.54		8.63	8.45	T2	
14.62		13.25	16.00	T1	F3
10.88		10.25	11.50	T2	
0.813	LSD F*T	N.S		LSD F*T*M	
F		F * M			
The average ionic strength		M1	M0	Ionic strength	
6.45		5.41	7.49	F1	
10.52		10.38	10.66	F2	
12.75		11.75	13.75	F3	
0.575	LSD F	0.813		LSD F* M	
T		T * M			
soil texture average		M1	M0	soil texture	
12.19		10.96	13.41	T1	
7.62		7.39	7.85	T2	
0.469	LSD T	0.664		LSD T*M	
M					
		M1	M0	Humic acid (M)	
		9.18	10.63	Humic acid average (M)	
		0.469		LSD M	

Source: - Prepared by the researcher

As for the binary combination between soil texture and ionic strength, the results of the analysis showed a significant effect of the dissolved sodium ion, as the highest value reached 14.62 mmol L^{-1} in the combination F3T1 and the lowest value amounted to 3.46 mmol L^{-1} in the combination F1T2, and this is attributed to the different levels of soil salinity and the difference Soil textures in their sodium content indicate that this result is consistent with what was obtained by Al-Mamouri (2004), Ahmed et al. (2006) and Ashraf (2018).

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The combination between the ionic strength and the levels of addition of organic matter showed a significant effect, as the combination F3M0 showed its superiority, amounting to 13.75 mmol L^{-1} compared to other combinations, while the combination F1 M1 gave the lowest value for dissolved sodium 5.41 mmol L-1.

The combination between the levels of organic matter (humic acid) and soil tissue showed a significant effect, as the highest value for the combination T1M0 showed 13.41 mmol L^{-1} and the lowest value was 7.39 in the combination T2M1 for the dissolved sodium ion.

The resulting triple combination of ionic strength, addition of humic acid and soil texture showed no significant effect on the sodium ion concentration for the harvesting stage, although the value of the combination F3T1M0 was 16 mmol L^{-1} and the value of the combination F1T2M1 was 3.30 mmol L^{-1}.

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