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Effect of different treatments to reduce the salinity of irrigation water on the growth and yield of wheat

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Abstract:

A field experiment was conducted under the conditions of Muthanna Governorate during the 2022-2023 agricultural season in one of the fields belonging to a farmer in the Al-Bandar area (3 km from the center of Samawah city), which is located at longitude 45.18 east and latitude 31.19 north. The experiment aimed to study the effect of different treatments in reducing the impact of irrigation water salinity on the growth and yield of wheat (*Triticum aestivum* L.). Variety Abaa 99 The experiment was conducted using a split-plot design with complete randomized blocks with three replications. The main plots included levels of irrigation water salinity with concentrations of (6, 9 and 12) dS m^{-1} in addition to the control treatment of normal river water (3) dSm^{-1}. The secondary plots included some salinity reduction treatments, namely (Kamasol, Clean Salt, magnetic irrigation water). The results of the experiment showed that the Clean Salt treatment significantly outperformed the control treatment in terms of plant height (95.50 cm), flag leaf area (34.07 cm^2), number of tillers (412.50 tillers m^2), and grain yield (6.210 t ha^{-1}). While salinity levels significantly affected some of the studied traits, the irrigation water treatment (control) was superior in the flag leaf area, recording 35.61 cm^2. The 6 dS m^{-1}

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treatment, on the other hand, outperformed the other treatments in terms of biological yield, recording the highest yield of 13.458 t ha^{-1}. The interaction between the factors of the experiment had a significant effect on some of the studied traits.

Keywords: Wheat; irrigation water salinity; magnetization; Kamasol; Clean Salt.

Interaction

Water scarcity for agricultural purposes is one of the main problems facing many countries in the world, especially Iraq, in expanding the production of this crop. The problem is likely to worsen in the coming years. Iraq's location in the dry and semi-arid regions, characterized by low rainfall and high temperatures, has caused 70-80% of the land in the central and southern regions to be classified as medium to highly saline (1). In the face of this great challenge, many efforts have been made in different parts of the world to find solutions to this problem, including the use of saline water sources such as well water and agricultural drainage. This requires, in addition to the development of salt-tolerant varieties, the improvement of the environment surrounding the crop by using the best soil and crop management practices.

The use of magnetized water technology and some special compounds for treating salinity, such as Kamasol and Clean Salt, can be one of the factors in increasing production by taking advantage of water of lower quality to compensate for the shortage of fresh water. Water magnetization is one of the techniques used to treat irrigation water, and it has given acceptable results regarding its effectiveness in improving the properties of the soil treated with magnetized water. Water magnetization is one of the technologies that can help to find solutions to rebalance water molecules and as a means of water conservation (2). The magnetization process is summarized by passing the water through a magnetic field with a specific discharge, which leads to the breakdown of hydrogen bonds and the destruction of the random structures resulting from the bonding of water molecules with each other. This leads to the arrangement of water molecules in the form of chains. This structure makes water more capable of dissolving minerals and salts in the soil, increases the availability of nutrients for the plant, and makes the entry of water through the roots easier and faster compared to non-magnetized water, which leads to accelerating plant growth (3).

As for the Kamasol compound, it is an organic calcium compound specifically designed to correct salinity problems. It contains exchangeable ionic calcium to correct salinity in water and soil and reduce the exchangeable sodium ratio. This helps to improve plant metabolism strengthen its immunity under high salinity conditions and reduce its negative impact on the plant (4). Clean Salt, on the other hand, is a compound consisting of calcium, nitrogen, and organic materials that work to treat high salinity and improve soil properties by breaking the bond of sodium with the soil and replacing it with calcium. This helps to wash sodium out of the lower layers of the soil, in addition to liberating chlorine, which becomes free and can be easily neutralized (5).

Materials and Methods

The field experiment was carried out under the conditions of Al-

Muthanna Governorate during the 2022-2023 agricultural season in one of the fields belonging to a farmer in the Al-Bandar area (3 km to the center city of Samawah). To study the effect of different treatments in reducing irrigation water salinity on the growth and yield of wheat.

A soil sample was taken at a depth of 30 cm after scraping the surface layer. A number of samples were mixed to arrive at a sample that accurately represents the field. It was analyzed in the laboratory of the College of Agriculture, Al-Muthanna University, the results were as shown in Table (1).

Table (1) Some chemical and physical characteristics of field soil before planting

Characteristics		Valuable	Unit
pH		6.92	
Ec		4.0	$dS\ m^{-1}$
R. Nitrogen		18.9	$mg\ kg^{-1}$ soil
R. Phosphorus		22.3	
R. Potassium		217.0	
Soil separators	Clay	22.33	$g\ kg^{-1}$
	Silt	29.12	
	Sand	48.54	
Soil texture		Sandy clay	

The experiment was conducted on slab design using a complete randomized block design (RCBD) with three replicates. The main slabs included levels of saline stress (6, 9 and 12) $dS\ m^{-1}$, in addition to the control treatment of normal river water (3) $dS\ m^{-1}$, and were assigned the symbols (W1, W2, W3, W4) respectively. The secondary slabs included salinity reduction agents (komosol, Clean Salt, Magnetization), in addition to the control treatment, and were assigned the symbols (T1, T2, T3, T4) respectively. The factors were randomly distributed within each block, and thus the total number of experimental units became 48, as shown in Table (2).

Table (2) Experiment factors

The first factor	The second factor
Control treatment: normal river water (W1)	**Control (T1):** normal river water
Water with a salt concentration of 6 dS m^{-1} **(W2)**	**Kamasol (T2)**: Its chemical composition consists of: %28.4 calcium oxide Cao An amount of 250 grams per 1,000 liters of water Kamasol compound was added to the irrigation water in two batches, the first after germination and the second 15 days after the first batch, according to the instructions of the product manufacturer.
Water with a salt concentration of 9 dS m^{-1} **(W3)**	**Clean Salt (T3):** Its chemical composition consists of: Calcium 14%, nitrogen 10%, active organic materials 23%, and total organic materials 53%. One liter of Clean Salt was added to every 1,000 liters of water with irrigation water in two batches, the first after germination and the second 15 days after the first batch, according to the instructions of the product manufacturer.
Water with a salt concentration of 12 dS m^{-1} **(W4)**	**Magnetization (T4):** Is a stainless tube inside which there are opposite magnetic rods whose function is to generate magnetic lines in a radial direction with a strength of 3000 gauss up to 30 thousand liters/hour. The magnetization device was connected to a plastic irrigation system with a diameter of 1.5 inches to deliver the magnetized water and all salt levels to the panels throughout the experiment.

Results and Discussion

1- Plant height (cm)

The results of Table (3) indicate a significant effect of salinity reduction agents on the height of wheat plants (cm). The results indicate that treatment T3 (Clean Salt) had the highest average height of 95.50 cm, significantly higher than treatment T2 (Kamasol), which had the lowest average height of 87.67 cm. Treatment T3 did not differ significantly from treatment T4 (Magnetization), which had an average height of 93.25 cm. This superiority may be attributed to the fact that Clean Salt contains 12% calcium, which contributed to the compound playing an effective role in increasing the ability of plants to tolerate salinity stress by maintaining membrane integrity and regulating selective permeability, especially in the plasma membrane (6). The presence of organic matter in the product also contributed to reducing the negative effects of salinity. In addition to providing the plant with nitrogen and calcium, which increases plant growth and strength. These results are consistent with (7), who found that there was a significant increase in plant height when using the Clean Salt compound. The decrease in plant height may be due to the increase in osmotic pressure in the plant growth medium, which causes a decrease in the absorption of water and nutrients due to salinity stress, which leads to the closure of stomata and reduced photosynthesis, resulting in a decrease in plant height (8).

As for the effect of interaction, it was significant, where the interaction treatment (W3×T3) achieved the highest average of 101.67 cm, while the interaction treatment (W2×T2) recorded the lowest average for this trait of 80.00 cm. The reason for the increase in plant height in the interaction treatment may be attributed to the role of the active organic matter in the Clean Salt compound, which contributed to improving the chemical properties of the soil and reducing salinity stress through the action of hydroxyl and carboxyl groups by forming sodium humates and fulvates resulting from the exchange of hydrogen ions present on the active functional groups (COOH, OH) with the positive ions in the soil solution (7).

Table (3) Effect of salinity reduction treatments and irrigation water salinity levels on plant height (cm)

Salinity levels (W)	salinity reduction treatments (T)				Average Salinity levels (W)
	T1	T2	T3	T4	
W1	91.33	93.00	90.33	86.33	90.25
W2	100.00	80.00	95.33	90.00	93.58
W3	85.33	93.33	101.67	92.67	93.25
W4	83.67	84.33	94.67	95.00	89.42
Average Treatment (T)	90.08	87.67	95.50	93.25	
L.S.D $_{0.05}$		W	T	W × T	
		N.S	3.317	6.937	

2. Flag leaf area (cm^2)

The results of Table (4) indicate a significant effect of salinity reduction agents on the flag leaf area (cm^2) trait of wheat crop. Treatment T3 had the highest average flag leaf area of 34.07 cm^2, significantly higher than the control treatment T1 (normal river water), which had the lowest average for this trait of 22.50 cm. Treatment T3 did not differ significantly from treatments T2 and T4, which had average flag leaf areas of 33.26 and 32.69 cm^2, respectively. The increase in flag leaf area may be attributed to the role of the organic matter present in the Clean Salt compound, which works to reduce the salinity ratio, resulting in increased water absorption and increased availability of nutrients to the plant, especially nitrogen, which helps to promote vegetative growth. Additionally, the compound's good calcium content is beneficial in improving soil properties by replacing calcium with sodium on the exchange complex, thereby releasing it into the soil solution and eliminating it, which contributes to improving plant growth and increasing leaf area (9). These results are consistent with those of Al-Tahavi (7).

As for the salinity levels, the results of the statistical analysis indicated a significant difference between the average values of the trait, with the control treatment W1 (river water) having the highest average of 35.61 cm2, while the high salinity level W4 had the lowest average flag leaf area of 27.28 cm2. This may be because the flag leaf area is reduced, its cells' elongation decreases, and it stops growing when it is exposed to high salt concentrations, either in irrigation water or soil, due to the low water absorption by the roots, which results in reducing the filling pressure inside the plant cell in the leaf, causing it to be reduced (10). Additionally, the increase in flag leaf area in the control treatment may be due to the leaf area being fully completed and expanded without being exposed to the effects of salinity stress. This is consistent with the findings of (11), who indicated that a decrease in leaf area occurs due to increased salinity stress.

Table (4) Effect of salinity reduction treatments and irrigation water salinity levels on flag leaf area (cm^2)

Salinity levels (W)	Salinity reduction treatments (T)				Average Salinity levels (W)
	T1	T2	T3	T4	
W1	28.32	37.47	39.16	37.50	35.61
W2	22.30	31.60	32.42	32.61	29.73
W3	19.86	32.85	36.42	30.41	29.89
W4	19.52	28.85	28.26	32.51	27.28

Average Treatment (T)	22.50	32.69	34.07	33.26	
L.S.D $_{0.05}$		W	T	W × T	
		5.387	2.816	N.S	

3. Tillers number (tillers m^2)

The results in Table (5) indicate a significant effect of salinity reduction agents on the number of tillers per square meter trait of wheat crop. Treatment T3 had the highest average of 412.5 tillers per square meter, significantly higher than treatment T1, which had the lowest average of 366.5 tillers per square meter. Treatment T3 did not differ significantly from treatments T4 and T2, which had averages of 411.1 and 396.1tillers per square meter respectively. The superiority of treatment T3 may be attributed to the role of the experimental factors in reducing the effects of salinity stress and stimulating cells to divide and contributing to the release of tillers from the inhibition resulting from apical dominance, which increases their number (12). The increase in the number of tillers can also be attributed to the fact that Clean Salt contains a good percentage of calcium, which contributed to improving soil properties and ridding it of sodium by a calcium exchange process and preventing the formation of toxic ions. This contributed to reducing osmotic pressure and improving plant activity, thereby increasing the number of tillers. This is consistent with the findings of Al-Tahavi (7) in his study on the eggplant plant. It is also consistent with (13) in his study on the pomegranate plant.

As for the effect of the interaction between salinity levels and treatments, it had a significant effect. Treatment (W1×T2) of normal water with Comosol had the highest average of this trait of 456.11 tillers per square meter, while treatment (W4×T1) of water with a salinity concentration of 12 dS/m had the lowest average of 315.56 tillers per square meter. The decrease in the number of tillers in the high salinity level may be due to the osmotic pressure caused by salinity stress and its effect on the vegetative and root systems by reducing the number of leaves and their surface area, which causes a decrease in the products of photosynthesis and the amount of nutrients needed during the period of emergence of tillers from the main stems. As a result, the competition between them and the products increases, and the number of tillers decreases. In addition, there is a decrease in the chlorophyll and water content of the leaves, so the stomata close the rate of CO_2 fixation inside the plant decreases, and the number of tillers decreases. In addition, the number of tillers is reduced as a result of apical dominance. These results are consistent with (14), who indicated a decrease in the number of tillers under the influence of salinity stress.

Table (5) Effect of salinity reduction treatments and irrigation water salinity levels on tillers number (tillers m^2)

Salinity levels (W)	Salinity reduction treatments (T)				Average Salinity levels (W)
	T1	T2	T3	T4	
W1	376.1	456.1	388.9	360.6	395.4
W2	426.1	317.2	413.9	390.0	386.8
W3	348.3	424.4	453.3	395.6	405.4
W4	315.6	446.7	393.9	438.3	398.6

Average Treatment (T)	366.5	411.1	412.5	396.1	
L.S.D $_{0.05}$		W	T	W × T	
		N.S	33.23	60.19	

4. Biological yield (t ha^{-1})

The results of Table (6) showed a significant increase in the biological yield trait using salinity reduction agents. Treatment T3 had the highest average of 13.365 t ha^{-1}, which was not significantly different from treatment T4, which had a high average of 13.255 t ha^{-1} and was superior to the control treatment T1, which gave the lowest average of 11.485 t ha^{-1}. The increase in biological yield can be attributed to the positive role of salinity reduction treatments in improving growth and yield traits by achieving the highest averages in the plant height trait (Table 3), leaf area trait (Table 4), and tiller number trait (Table 5), which increased biological yield. These results are consistent with those of Al-Tahavi (7).

Salinity levels also had a significant effect on the biological yield trait. Treatment W2, with a salinity level of 6 dS/m, had the highest average of 13.458 t ha^{-1}, compared to the control treatment, which had the lowest average of 11.261 t ha^{-1}. The increase in biological yield in treatment W2 may be because it achieved high average values for the plant height trait, 1000-grain weight trait, and grain yield trait (Tables 3, 10 and 11), respectively. These results are consistent with those of (16), who indicated that an increase in the average of these traits is reflected positively in the increase in dry matter accumulation, through an increase in the rate of photosynthesis, protein synthesis, and carbohydrate content.

The interaction between salinity levels and treatments had a significant effect on the biological yield trait. Treatment (W3×T3), with a salinity level of 6 dS/m and treatment T3, had the highest average of 15.271 t ha^{-1}, while treatment (W4×T1), with a salinity level of 12 dS m^{-1} and treatment T1, had the lowest average of 9.583 t ha^{-1}. The decrease in the average biological yield with increasing salinity stress is a logical result due to the low accumulation of dry matter in the plant, as a result of the decrease in the overall growth rate of the plant, recording the lowest averages in the plant height trait, flag leaf area trait, 1000-grain weight trait, and grain yield trait, which negatively reflect on biological yield.

Table (6) Effect of salinity reduction treatments and irrigation water salinity levels on biological yield (t ha^{-1})

Salinity levels (W)	Salinity reduction treatments (T)				Average Salinity levels (W)
	T1	T2	T3	T4	
W1	10.379	10.875	11.542	12.250	11.261
W2	14.521	11.417	13.354	14.542	13.458
W3	11.458	12.875	15.271	12.417	13.005
W4	9.583	12.250	13.292	13.812	12.234
Average Treatment (T)	11.485	11.854	13.365	13.255	
L.S.D $_{0.05}$		W	T	W × T	
		0.9680	0.9680	1.9360	

Conclusions

Based on the results obtained, we conclude the following:

- It is possible to irrigate with water with a salinity level of up to 3 dS/m without the need to use salinity treatments, as indicated by the superiority of this level in many growth and yield traits.
- The Clean Salt salinity treatment is the best soil conditioner for its positive role in improving growth and yield traits, which was reflected in the grain yield, as indicated by its superiority in the traits of (plant height, flag leaf area, number of tillers, and biomass yield).
- The salinity treatments Clean Salt, Comosol, and Magnetization contributed to increasing plant tolerance to irrigation with saline water at a level of 6, 9 and 12 dS m^{-1}, as indicated by the superiority of these treatments in the traits of (plant height, flag leaf area, and biomass yield).

References

1. Abdel, C.G., and Alsaberi, M.R., 2010. Production of well-irrigated radishes (*Raphanus sativus* L.). The influence of naphthalene-3- acetic acid (NAA) on growth and yield of furrow cultivated Local black radish cultivar. Babylon Education Journal, 1(5), pp. 98-106.
2. Al-Rikabi, A. K. Y. 2015. The effect of water magnetization on irrigation water quality, water consumption efficiency, and the chemical behavior of phosphorus. Doctoral thesis - College of Agriculture - University of Basrah.
3. Jakson, M.L. 1958. Soil Chemical Analysis. Prentic Hall. Inc. Englewood, Cliffs, N. J.
4. COMPO EXPERT www.compo-expert.com
5. Al-Joud Company. product information brochure.
6. Al-Zanbouri, A. K. A. 2053. Using some treatments to reduce salt stress in the growth and production of wheat, Sham variety. Master's thesis, College of Agriculture. Al-Qasim Agricultural University. Iraq.
7. Al-Tahafy, S. A. A., Abdel, S. H., Hamed, A. H., and Nima, H. A., (2015). Response, growth, and yield of Hibiscus abdariffa L. to the addition of a salinity treatment (Clean Salt). Spraying with organic fertilizer (Humic

Aljohara) in high-salinity soil. Kufa Journal of Agricultural Sciences, 7(1): 73-93.

8. Khattab, M. N., Majd, D., Alaa, M. (2019). Individual selection in a local population of yellow maize *Zea maya* L. for the most important economic traits under conditions of salt stress. Department of Field Crops - Faculty of Agriculture - Tishreen University. Latakia. Syrian. 6(2):308-324.
9. Al-Sahhaf, F. H. 1989. Applied Plant Nutrition, House of Wisdom, Ministry of Higher Education and Scientific Research, Baghdad - Iraq. p.5.
10. Al-Rahbawi, S. M. J. 2012. The effect of the quality and quantity of irrigation water on the growth and productivity of wheat (*Triticum aestivum* L.) in Najaf Governorate. Master Thesis. College of Science - University of Kufa.
11. Abd El-Samad. H.M. 2013. The physication applaological response of wheat plants to exogenous application of gibberellic acid (GA3) or indole-3. acetic acid (IAA)with endogenous ethylene under salt stress conditions.
12. Sakakibara, A. R., Fatkhutdinova, D. R., Bezrukova, M. V. and Shakirova F. M. 2006. kinetin prevents the damaging action of stress factors on wheat plants. Bulg. J. Plant Physiol., Speical Issue:314-319.
13. Edward, W., Y., 2016. Response Punicagranatum Trees to Clean Salt. J. Plant Nutr. 15 (2), p. 199-209.
14. Prism, T. H., Intisar, A. K. T. 2015. The effect of organic matter and irrigation water salinity on some soil characteristics and wheat plant growth. Al-Furat Al-Awsat University, Al-Musayyib Technical College. Volume 17, Issue 2,1-1
15. Al-Sahuki, M. M. 2013. Breeding crops to withstand abiotic stress. A partial and metagenetic view. College of Agriculture - University of Baghdad, p. 82.
16. Al- Nuaimi, H. T. A. 2015. The effect of irrigation water salinity and spraying with gibberellin and potassium on the growth and yield of wheat. Field Crops Department. College of Agriculture - University of Baghdad.