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Role of Salt Ameliorant (Clean Salt) In Reducing the Effects of Salinity and Improving the Productivity of *Hordeum Vulgare* L.

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Abstract

To determine whether Clean Salt, a salt conditioner, could alleviate salinity stress in barley, we established a field experiment in Thi-Qar Governorate, Iraq, during the 2024–2025 growing season. Four irrigation salinity levels—4.5 (control), 6, 9, and 12 dS m^{-1}—were tested in combination with three Clean Salt application rates: 0, 0.5, and 1 liter per 1000 liters of water. A split-plot design with three replications was used to assign treatments. We looked at several yield-related traits, including grain yield, harvest index, 1000-grain weight, spikes per square meter, and grains per spike. As salinity increased, most of these traits tended to decline, though grains per spike held steady. For example, grain yield dropped from 6.37 t ha^{-1} in the control treatment to 5.40, 4.69, and finally 3.59 t ha^{-1} under the highest salinity level—a statistically significant reduction. Across salinity levels, C2 improved spikes m^{-2} (253 vs. 235), 1000-grain weight (41.73 vs. 38.12 g), grain yield (5.453 vs. 4.512 t ha^{-1}), and harvest index (43.50% vs. 39.74%) compared to C0 (LSD 0.05 = 2.15, 0.65 g, 0.217 t ha^{-1}, 1.74%, respectively). The C1 rate showed intermediate effects. A significant interaction (C2 × W0) produced maximum spikes m^{-2} (280.33), 1000-grain weight (49.00 g), and yield (7.369 t ha^{-1}) ($LSD_{0.05}$ = 16.54, 1.94 g, 0.707 t ha^{-1}). However, Clean Salt effectiveness diminished markedly at W3, recovering only 11.2% of yield loss compared to 34% recovery of 1000-grain weight loss. At a rate of 1 L per 1000 L of water, Clean Salt proved effective at reducing salinity stress in barley under low to moderate salinity levels (up to 9 dS m^{-1}). However, its performance dropped off sharply at 12 dS m^{-1}, suggesting that it cannot stand alone under severe salinity and may need to be combined with other management strategies.

Keywords: *Hordeum vulgare*, salinity stress, soil conditioner, yield components, salinity threshold, Iraq

Introduction:

Barley is one of the oldest cultivated grains and remains a key crop for global food security. It ranks fourth in importance after wheat, maize, and rice, and was once a staple ingredient in bread-making. Beyond its carbohydrate content, barley provides essential amino acids and proteins important for human nutrition. It is also a good source of fiber, selenium, and B vitamins (Noreen et al., 2025).

Global barley cultivation area is estimated at about 5.514 million hectares, with a production of about 538 million tons. In Iraq, barley ranks second in importance, cultivated area, and production. In the winter of 2023, the area planted with barley in Iraq reached approximately 2344 thousand dunams, while the total production reached 106 thousand tons, (Central statistical organization [CSO], 2023). As a result, productivity levels fail to reach global standards. One of the reasons for this decline may be due to the lack of use of modern technologies in the field of crop service, particularly during critical stages of the crop life cycle, (Demelash et al., 2025). The scarcity of water resources is one of the most prominent challenges facing countries around the world (AL-Hudaib et al., 2025), especially Iraq, in light of its efforts to enhance agricultural crop production. This problem is expected to worsen in the coming years. In response to this major challenge, significant efforts have been made to find innovative solutions. This included the utilization of non-traditional water resources, such as saline groundwater and agricultural drainage water (Nazir et al., 2025). This requires the implementation of best practices in soil and crop management, in addition to enhancing the surrounding environment of agricultural crops. Modern technologies, such as the use of salt-treating compounds like Clean Salt, can enhance productivity by utilizing saline water to offset the shortage of freshwater, Clean Salt functions by breaking the association of sodium with the soil, thus enabling its substitution with calcium (Budhlakoti et al., 2022). This procedure contributes to transporting sodium to deeper soil layers, in addition to releasing chlorine and rendering it free, which facilitates its effective immobilization, (Batool et al., 2026). The study aims to:

Studying the tolerance level of barley to different salinity levels to achieve optimal yield.

Studying the effect of the optimal level of the salt conditioner “Clean Salt” in enhancing barley tolerance to irrigation with saline water while achieving improved productive traits.

Studying the optimal interaction between levels of the salt conditioner and saline water irrigation levels to achieve superior yield traits of barley.

Materials and methods:

A field experiment was conducted during the 2024–2025 cropping season on agricultural land located in Sayid Dakhil District, southeast of Thi-Qar Governorate, at the geographical coordinates of latitude 31^0 and longitude 46^0. The study focused on barley (cv. Aksad) to investigate the effect of the salt ameliorant Clean Salt on mitigating salinity stress and improving the growth and productivity of the barley crop.

A set of soil samples was collected from a depth of (0–30) cm after the surface layer was removed. The samples were thoroughly mixed to form a composite sample accurately representing the field, which was then analyzed at the Directorate of Agriculture Laboratory, Dhi Qar Governorate. The results are presented in Table (1).

Table (1). The physicochemical characteristics of the experimental field pre-planting

Attribute	Values	Units
pH	7.20	
E.c(1:1)	6.50	ds/m^{-1}
Nitrogen(available)	12.60	Mg/kg dry weight
phosphorus(available)	13.20	Mg/kg dry weight
potassium(available)	118.70	Mg/kg dry weight
Clay	48.54	g/kg^{-1}
Silt	29.12	g/kg^{-1}
Sand	22.33	g/kg^{-1}
Soil texture	silty clay	

The experiment was conducted using a split-plot arrangement under a Randomized Complete Block Design (RCBD). The main plots comprised salinity levels of (0, 6, 9, and 12) ds /m^{-1}, designated as (W0, W1, W2, and W3) respectively. The subplots included three levels of the salinity conditioner “Clean Salt” at (0, 0.5, and 1) L, designated as (C0, C1, and C2) respectively. The saline solution was prepared using sodium chloride (NaCl) according to the following equation: w × 0.640 = the required salt weight for preparing the concentrated solution, (Al-Naemi, 2015). The required amount of sodium chloride (NaCl) per liter of distilled water was determined to achieve an electrical conductivity of (6, 9, 12) $dS \cdot m^{-1}$. This was calculated using the equation described above for each of the desired salinity concentrations. As the electrical conductivity (EC) of the river water was recorded at 4.5 $dS \cdot m^{-1}$, the concentration of dissolved salts was estimated at 2.88 $mg \cdot L^{-1}$. The number of salts present in the river water was subsequently subtracted from the total required NaCl needed to obtain the

Four salinity levels were established for irrigation water: W0 (4.5 $dS \cdot m^{-1}$; river water), W1 (6 $dS \cdot m^{-1}$; 0.96 kg $NaCl \cdot 1000\ L^{-1}$), W2 (9 $dS \cdot m^{-1}$; 2.88 kg $NaCl \cdot 1000\ L^{-1}$), and W3 (12 $dS \cdot m^{-1}$; 4.8 kg $NaCl \cdot 1000\ L^{-1}$). target salinity level, and the remaining quantity was added to reach the desired concentration. The saline solutions were prepared in four tanks, each with a capacity of 1,000 L. The required amount of NaCl was added to the water with continuous stirring. The target salinity level was then verified using an electrical conductivity meter (EC meter). Subsequently, the prepared water was delivered to the experimental units through plastic pipes dedicated to each unit according to the specified salinity level. The salt conditioner (Clean Salt) was applied at two concentrations: 0.5 L/1,000 L water and 1 L/1,000 L water. Applications were made twice: once after germination and again 15 days later. A control treatment without conditioner (C0) was included for comparison. Plowing, leveling operations were performed on the experimental field, which was then divided according to the experimental design., and seeds were sown on November 1st, (Al-Jiyashi, 2020). The experimental field was subdivided into 36 experimental units, each measuring 1 × 1 m. Each unit consisted of five rows with a row spacing of 20 cm, and a seeding rate of 120 kg per hectare was applied, (General Authority for Agricultural Research, 2011). Nitrogen fertilization was applied at a rate of 120 kg/ha in the form of urea (46% N) in two split applications, following the determination of available soil nitrogen (Table 1). Phosphorus fertilization was applied at 100 kg/ha as triple superphosphate (46% P_2O_5), (Al-Abadi, 2011). and potassium fertilization was applied at 80 kg/ha in the form of potassium sulfate (50% K_2O), (Ali et al., 2014). Irrigation and the removal of weeds were performed as needed.

Table (2) composition of the salt-treatment product (Clean Salt), manufactured in the Kingdom of Saudi Arabia.

sequence	Materials	concentration
1	Nitrogen	9%

2	Calcium	12%
3	Active organic matters	23%
4	Total organic matters	63%

Results and discussion:

Clean salt application proved to be a key factor in boosting spike density (Table 3). The most effective treatment, C2 (a 1:1000 solution), resulted in an average of 253.08 spikes per square meter. This was a 7.8% improvement over the control's 234.67 spikes. It's likely that the clean salt improved conditions in the root zone and reduced the toxic effects of ions, which in turn helped the plants take up more water and nutrients—a boost that would naturally support more tillers and, ultimately, more spikes (Al-Tahafi et al., 2015; Al-Ali, 2024).

The salinity of the irrigation water also played a major role. Under non-saline conditions (W0), plants produced 265.33 spikes m^{-2}. As salt levels increased, this number steadily fell, dropping by 15% to just 225.56 spikes m^{-2} at the highest salinity of 12 dS m^{-1} (W3). This drop-off is a direct consequence of salt stress: the higher osmotic pressure and buildup of sodium and chloride ions make it harder for plants to absorb water and nutrients, which directly hampers tiller fertility (Guo et al., 2025).

Interestingly, there was a significant interaction between the two factors. The absolute best result came from combining the optimal clean salt treatment with fresh water (C2 × W0), which peaked at 280.33 spikes m^{-2}.The lowest yield, 218.67 spikes m^{-2}, was recorded in the high-salinity plots that missed out on the clean salt treatment (C0 × W3). This really highlights an important point: the treatment works best in good conditions, but it’s not wasted in bad ones—it still helps the plants cope with salt stress.

Table (3). Effect of Clean Salt Levels and Irrigation Water Salinity on Number of Spikes per m^2 (spikes m^2)

W / **C**	W_0	W_1	W_2	W_3	Clean Salt Averages
C_0	256.67	236.67	226.67	218.67	234.67
C_1	259.00	242.33	233.33	221.67	239.08
C_2	280.33	251.67	244.00	236.33	253.08
Average salinity	265.33	243.56	234.67	225.56	
L.S.D 0.05	W		C		WXC
	16.487		2.152		16.537

Grain number per spike showed no significant response to clean salt application, irrigation water salinity, or their interaction (Table 4). Values ranged from 58.67 to 62.67 grains spike^{-1} across all treatment combinations, with treatment means of 60.67 (C0), 61.42 (C1), and 61.58 (C2) for clean salt levels, and 60.00 (W0) to 62.33 (W3) for salinity levels. The absence of significant differences indicates that grain number per spike was conserved across treatments, suggesting this yield component may be less sensitive to both salinity stress and clean salt amelioration under the conditions tested (Gaafar et al., 2025).

Table (4). Effect of Clean Salt Levels and Irrigation Water Salinity on grains number per spike (spikes^{-1}).

W / C	W_0	W_1	W_2	W_3	Clean Salt Averages
C_0	60.00	58.67	61.67	62.33	60.67
C_1	59.67	61.33	62.67	62.00	61.42
C_2	60.33	61.33	62.00	62.67	61.58
Average salinity	60.00	60.44	62.11	62.33	
L.S.D 0.05	W		C		WXC
	n.s		n.s		n.s

Table (5) showed indicates that the third level of Clean Salt showed a significant superiority, recording the highest mean value of (41.73 g), whereas the control treatment recorded the lowest mean value of (38.12 g) for the trait of 1000-grain weight. This superiority may be attributed to the physiological role of Clean Salt in improving the osmotic balance in the root zone and reducing the ionic toxicity resulting from the accumulation of sodium and chloride ions. These effects collectively enhance the plant's efficiency in absorbing water and essential nutrients and help maintain photosynthetic activity during the grain-filling stage, thereby increasing 1000-grain weight., (Al-Tahafi et al., 2015; Al-Ali, 2024; Rukhsar et al., 2026).

Table (5) showed the irrigation water salinity levels, the control treatment yielded the highest mean value of (45.77 g), while the W3 treatment (fourth salinity level) gave the lowest mean value of (35.31 g) for the trait of 1000-grain weight. The reduction in the 1000-grain weight may be attributed to the adverse effects of salt stress, which limits the plant's absorptive capacity, increases osmotic pressure, and enhances ionic toxicity. These combined factors ultimately lead to a decline in grain filling and a consequent reduction in the1000-grain weight (El Hajjami et al., 2026).

Table (5) showed Regarding the interaction between Clean Salt and the salinity levels of the irrigation water, the overlap treatment (C_2XW_0) recorded the highest 1000-grain weight, reaching (49.00 g), In contrast, the treatment without Clean Salt under the highest salinity level (12 $dS·m^{-1}$) produced the lowest mean value, which was (33.40 g). This superiority may be attributed to the effective role of the salt amendment in improving rhizosphere conditions and mitigating the adverse effects of salinity stress, particularly by reducing the toxic accumulation of sodium and chloride ions. This, in turn, enhanced water and essential nutrient uptake, which was positively reflected in photosynthetic efficiency, vegetative growth, the formation of a 1000 grain weight. In contrast, the absence of the salt amendment under high salinity conditions resulted in increased osmotic stress around the roots and disruption of ionic balance within the plant, thereby limiting water and nutrient absorption and negatively affecting physiological processes, which was reflected in a marked reduction in 1000-grain weight (Demo et al., 2025).

Table (5). Effect of Clean Salt Levels and Irrigation Water Salinity on 1000-grain weight (g).

W / **C**	W_0	W_1	W_2	W_3	Clean Salt Averages
C_0	43.17	40.27	35.63	33.40	38.12
C_1	45.13	41.00	37.37	35.87	39.84
C_2	49.00	42.97	38.30	36.67	41.73
Average salinity	45.77	41.41	37.10	35.31	
L.S.D 0.05	W		C		WXC

	1.801	0.647	1.940

Table (6) showed indicates that the third level of Clean Salt showed a significant superiority, recording the highest mean value of(5.453 t ha^{-1}), whereas the control treatment recorded the lowest mean value of (4.512 t ha^{-1}) for the trait of grain yield, The superiority of the (C_2) of Clean Salt in grain yield may be attributed to its enhancement of the number of spikes per m^2 (Table 3) and the improvement in the trait of 1000 grain weight (Table 5) (Abdelghany et al., 2025).

Table (6) shows a significant effect of irrigation water salinity on grain yield. The control treatment recorded the highest mean of (6.371 t ha^{-1}), whereas the (W3) produced the lowest mean yield, reaching (3.592 t ha^{-1}), this superiority in the control treatment may be attributed to the treatment's significant increase in the number of spikes per m^2 (Table 3) and its superiority in 1000-grain weight (Table 5). (Al-Naemi, 2015; Al-Ali, 2024).

Table (6) showed Regarding the interaction between Clean Salt and the salinity levels of the irrigation water, the overlap treatment (C_2XW_0) recorded the highest grain yield weight, reaching (7.369 t ha^{-1}), In contrast, the treatment without Clean Salt under the highest salinity level (12 $dS \cdot m^{-1}$) produced the lowest mean value, which was (3.333 t ha^{-1}). This superiority may be attributed to the effective role of the salt amendment in improving rhizosphere conditions and mitigating the adverse effects of salinity stress, particularly by reducing the toxic accumulation of sodium and chloride ions. This, in turn, enhanced water and essential nutrient uptake, which was positively reflected in photosynthetic efficiency, vegetative growth, the formation of a greater number of spikes, and increased grain weight, ultimately leading to higher grain yield. In contrast, the absence of the salt amendment under high salinity conditions resulted in increased osmotic stress around the roots and disruption of ionic balance within the plant, thereby limiting water and nutrient absorption and negatively affecting physiological processes, which was reflected in a marked reduction in grain yield., (Al-Tahafi et al., 2015)

Table (6). Effect of Clean Salt Levels and Irrigation Water Salinity on grain yield (t ha^{-1})

W / C	W_0	W_1	W_2	W_3	Clean Salt Averages
C_0	5.429	4.987	4.300	3.333	4.512
C_1	6.314	5.473	4.825	3.655	5.067
C_2	7.369	5.724	4.931	3.787	5.453
Average salinity	6.371	5.395	4.686	3.592	
L.S.D 0.05	W		C		WXC
	0.6684		0.2174		0.7069

Table (7) showed indicates that the third level of Clean Salt showed a significant superiority, recording the highest mean value of (43.50%), whereas the control treatment recorded the lowest mean value of (39.74%) in harvest index may be attributed to its The superiority observed at the C2 level of Clean Salt may be attributed to its role in reducing the toxic accumulation of sodium and chloride ions in the root zone, which contributed to improving ionic balance within the plant and enhancing the uptake of essential nutrients such as nitrogen, potassium, and calcium. This improvement was positively reflected in the efficiency of physiological processes, particularly photosynthesis, as well as in the increased activity of enzymes responsible for growth and dry matter accumulation. Furthermore, the improvement in the plant's nutritional and water status led to enhanced vegetative growth traits and yield components, which was directly reflected in the harvest index (Al-Tahafi et al., 2015).

no significant differences among the levels of irrigation water salinity, as well as their Interferences interaction.

Conclusions:

1 - The Clean Salt treatment showed a significant effect in improving the yield components of the barley crop, as the third level (1 liter/1000 liters) significantly outperformed the other levels in the number of spikes per m^2, 1000-grain weight, grain yield and harvest index.

2 - The increase in salinity of irrigation water led to a gradual decrease in yield characteristics, as the non-saline water irrigation treatment (W0) recorded the highest values, while the highest salinity (W3 = 12 dS m^{-1}) recorded the lowest values for all studied yield characteristics.

3 - That Clean Salt effectively mitigates the impact of salinity at low to moderate levels; however, its effect becomes decisive under high salinity conditions, highlighting the need for additional management practices in severe environments.

Table (7). Effect of Clean Salt Levels and Irrigation Water Salinity on moisture content at harvest index (%).

W / C	W_0	W_1	W_2	W_3	Clean Salt Averages
C_0	42.49	41.56	40.30	34.62	39.74
C_1	47.23	44.30	42.70	36.52	42.69
C_2	49.83	44.66	42.28	37.25	43.50
Average salinity	46.52	43.51	41.76	36.13	
L.S.D 0.05	W		C		WXC
	n.s		1.740		n.s

Suggestions:

1 - Suggested that the Clean Salt treatment be used at a level of (1 liter/1000 liters) when growing in saline soils or waters, due to its effective role in improving the yield and its components.

2 - Suggested Conduct future studies to evaluate the effect of clean salt treatment on physiological characteristics (chlorophyll content, photosynthetic efficiency), root characteristics, and salt stress tolerance.

3 - Suggested to study the interaction between salt treatment and mineral or organic fertilizers to see the possibility of improving the efficiency of use and reducing agricultural costs. The experiment should be repeated in different environments and agricultural seasons to verify the stability of the results and the possibility of generalizing them on a wider scale.

References:

Al-Abadi, J. I. (2011). Guide to the use of chemical and organic fertilizers in Iraq (pp. 1–93). General Directorate of Agricultural Guidance and Cooperation, Ministry of Agriculture, Iraq.

Al-Ali, S. N. A. (2024). The effect of some technologies to mitigate the impact of irrigation water salinity on the growth and yield of wheat (Triticum aestivum L.) (Master's thesis). College of Agriculture, Al-Muthanna University.

Ali, N. S., Hamadallah, S. R., & Abdul-Wahab, A. R. (2014). Soil fertility (1st ed.). Ministry of Higher Education and Scientific Research, University of Baghdad; Dar Al-Kutub for Printing and Publishing.

Al-Jiyashi, M. T. A. (2020). Effect of cutting, sowing dates, and cultivars on growth traits and forage and grain yield of barley (Hordeum vulgare L.) (Doctoral dissertation). College of Agriculture, Al-Muthanna University.

Al-Naemi, H. T. (2015). Effect of irrigation water salinity and foliar application of gibberellin and potassium on the growth and yield of wheat (Master's thesis). Department of Field Crops, College of Agriculture, University of Baghdad.

Al-Tahafi, S. A. A., Hussain, A. S., Habeeb, H. A., & Athab, N. H. (2015). Response, growth, and yield of *Hibiscus sabdariffa* L. plants to the application of the salinity conditioner (Clean Salt) and foliar spraying with the organic fertilizer (Humic Aljohara) in high-salinity soil. Al-Kufa Journal for Agricultural Science, 7(1), 73–93.

Gani,A.J.and K.A.Salman. (2011). Barley from agriculture to harvesting. Published by The General Authority for Agricultural Research.

General Authority for Agricultural Research. (2011). Barley: From cultivation to harvest. Ministry of Agriculture, General Directorate of Agricultural Guidance and Cooperation, Republic of Iraq.

Central Statistical Organization [CSO]. (2023). Agricultural statistics survey 2023. Republic of Iraq, Ministry of Planning.

Abdelghany, M., Saad, K. I., Dakrory, M., & Amer, K. E. (2025). Multivariate analysis of agronomic characteristics in some Egyptian barley landraces: a field-based quantitative study. *BMC Plant Biology*, *25*(1), 1565.

AL-Hudaib, H., Adamo, N., Bene, K., Ray, R., & Al-Ansari, N. (2025). Application of Decision Support Systems to Water Management: The Case of Iraq. *Water*, *17*(12), 1748.

Batool, A., Zhang, K., Abbas, F., Akhtar, A., & Mao, J. (2026). A Comparative Evaluation of Soil Amendments in Mitigating Soil Salinization and Modifying Geochemical Processes in Arid Land. *Agronomy*, *16*(2), 222.

Budhlakoti, N., Kushwaha, A. K., Rai, A., Chaturvedi, K. K., Kumar, A., Pradhan, A. K., Kumar, U., Kumar, R. R.,

Juliana, P., Mishra, D. C., & Kumar, S. (2022). Genomic Selection: A Tool for Accelerating the Efficiency of Molecular Breeding for Development of Climate-Resilient Crops. *Frontiers in Genetics*, *13*. https://doi.org/10.3389/fgene.2022.832153

Demelash, A., Alehegn, M., & Menzir, A. (2025). Diversity, spatial distribution, breeding status, production level, and use dynamics analysis of food barley in Ethiopia. *Advances in Agriculture*, *2025*(1), 8830375.

Demo, A. H., Gemeda, M. K., Abdo, D. R., Guluma, T. N., & Adugna, D. B. (2025). Impact of soil salinity, sodicity, and irrigation water salinity on crop production and coping mechanism in areas of dryland farming. *Agrosystems, Geosciences & Environment*, *8*(1), e70072.

El Hajjami, E.-Z., Oufdou, K., Ouhaddou, R., El Mazouni, N., & Meddich, A. (2026). Coactive Role of Biochar and Rhizobacterial Consortia in Improving Photosystem II Performance, Antioxidant Response, and Enhancing Durum Wheat Tolerance Under Combined Salt-Drought Stress. *Journal of Soil Science and Plant Nutrition*, 1–20.

Gaafar, R. M., Khatab, I. A., & Mariey, S. A. (2025). Evaluation of salinity tolerance of Egyptian barley genotypes and their dehydrin 6-based single nucleotide polymorphisms (SNPs) diversity. *Journal of Genetic Engineering and Biotechnology*, *23*(4), 100614.

Guo, J., Chen, Y., Zhao, Y., Tian, H., Jiang, Y., & Zhang, Y. (2025). Molecular mechanisms of wheat acclimation to soil degradation: Insights into salt stress, heavy metal contamination, and nutrient deficiency. *Environmental and Experimental Botany*, *237*, 106193. https://doi.org/https://doi.org/10.1016/j.envexpbot.2025.106193

Nazir, M., Roy, K., Saha, A., Das, U., & Saha, D. (2025). Sustainable solutions for water scarcity: rehabilitating abandoned coal mine pit lakes through limnological analysis of freshwater resources in mining-affected regions. *Environmental Geochemistry and Health*, *47*(6), 223.

Noreen, S., Tufail, T., Mubashar, H., Bader-Ul-Ain, H., Hassan, A., Zafar, A., Aja, P. M., & Atoki, A. V. (2025). Antioxidant activity and phytochemical analysis of different varieties of barley (Hordeum vulgare L.) available in Pakistan. *Frontiers in Nutrition*, *12*, 1618457.

Rukhsar, A., Kanbar, O., Mahmoudi, H., Yousfi, S., Serret, M. D., & Araus, J. L. (2026). Influence of Saline Irrigation and Genotype on Yield, Grain Quality and Physiological Ideotypic Indicators of Bread Wheat in Hot Arid Zones. *Agronomy*, *16*(2), 270.