

Effect of Salinity of Irrigation Water on Mineral Content and Yield of Different *Hordeum vulgare* L. Plant Varieties

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Abstract:

The study was conducted in the gardens of the College of Education for Womens- Tikrit University, during the 2025-2026 season using plastic pots to study the minerals content and yield of three barley varieties (Rihaan, Arifaat, and Amal) under different levels of slinity irrigation water (0, 1000, 2000, and 3000)(ppm) of sodium chloride. The experiment was conducted using a completely randomized block design (RCBD), and the data were statistically analyzed according to Duncan's multiple range test at the 5% level, the results showed the following: The irrigation with salinity water 3000 ppm concentration gaved least percentage in chlorophyll content, Nitrogen ,Phosphor , Potassium percentage by 30.07, 45.52 ,26.19 and 6.89 % respectivelr compar to the irrigation with tab water. The variety Amal excelled in its total chlorophyll content and the aforementioned elements by a percentage 20.00 ,24.10, 55.18 and 11.11% respectivelt compar to Arifaat variety.The interaction between Amal variety and irrigation with normal water showed resulted in the highest percentage for the same traits, by respectively.The irrigation with salinty water with 3000 ppm concentration gave least seed yield percentage 91.61% and variety Amal superior by 131.16% and the interaction between Amal variety and irrigation with tab water 3000 ppm concentration gave highest seed yield reached 8.22 gm compare to Arifaat variety irrigated with salinty water 3000 ppm concentration which gave least yield reached 0.21 gm.

Keyword:barley+salinity+mineral content+yield

Introduction:

Stresses are of two types: biological stress, which includes disease, weeds, insects, etc., and abiotic stress, which is represented by water and salt stress, extreme temperatures, heavy metals, and oxidation. This type of stress is the negative factor affecting plant production (1), and it is responsible for a 50% decrease in plant yield, which constitutes a serious threat to global food security (2).

It refers to the increase in salt concentration in plant cells, which affects the plant's physiological characteristics due to the decrease in soil water potential, which negatively impacts the plant's morphological characteristics and restricts

the movement of water from the soil to the plant or from one cell to another (3). Salt stress is considered one of the abiotic stresses that negatively affect the life of a plant growing in a saline environment, whether it is saline soil or saline irrigation water (4).

Salt stress is one of the most harmful environmental stresses to agricultural production in the world (5). It leads to a series of morphological and physiological disturbances that affect plant growth, metabolism and production (5). Salt water leads to the dissolution of chlorophyll pigment, a decrease in the efficiency of photosynthesis and respiration processes, a

decrease in the production of proteins and carbohydrates, and ultimately leads to cell death (6).

Barley (*Hordeum vulgare* L.) is a globally used forage crop due to its high fiber content. Barley tolerates adverse environmental conditions, drought, and saline irrigation water (7). It is one of the most important cereal crops, included in the human diet in many parts of the world, and is also an important forage crop, especially with the increasing interest in livestock production (9). It ranks fourth among cereal crops in the Arab world after wheat, corn, and rice Globally, it ranks fifth (10, 11).

The importance of barley and its grains lies in their current use, accounting for

85% of animal feed grains or green fodder. Barley is a major component of animal feed rations and is also used in various industries and as a part of the human diet. Furthermore, barley is often mixed with legumes to enhance the nutritional value of the feed. Barley grains are also used in the production of malt, starch, and in some food and chemical industries (13). (14) indicated that barley grains contain proteins and amino acids important for human nutrition, as well as high levels of vitamins, fiber, selenium, and especially vitamin B.

The objective of this study was to investigate the mineral content and yield of three barley varieties under different levels of salinity irrigation water.

Materials and methods: The experiment conducted in the gardens of the College of Education for Women - Tikrit University from November St1 November, 2025 to 30 April 2026, using plastic pots with a diameter of 30 cm and a height of 40 cm containing a mixture of soil, to study the minerals content and yield content of three varieties of barley plants, namely (15), under different levels of irrigation water salinity (0, 1000, 2000, and 3000 parts per million. the experiment was carried out with a randomized complete block design (RCBD) with three replicates, using Duncan's test at a test level of 0.05 to compare the means.

The necessary tests were conducted on the agricultural soil in the laboratories of the Department of Soil and Water Sciences, College of Agriculture, Tikrit University. Soil texture was determined according to the method of (16), electrical conductivity according to the method of (17), and pH according to the method of (16), Phosphorus, potassium and calcium were estimated by the Flame Photometer, while total nitrogen was estimated using the microKjeldal device as described in

(18). Organic matter was estimated by the loss by incineration method as described in (19). Superphosphate P_2O_5 and urea fertilizer were applied at planting mixed with the soil, and urea fertilizer N 46% was added in two installments, half the amount at planting and the other half 40 days after planting.

***Studied Characteristics:**

*** Chlorophyll content ($mg\ g^{-1}$ wet weight):** Chlorophyll content in plant leaf tissues was determined according to the method described by (20). A 100 mg weight of fresh plant leaves was ground with 10 mL of 80% acetone using a ceramic mortar. The mixture was then centrifuged at 3000 rpm for 5 minutes. The filtrate was collected in a volumetric flask and the volume was rounded up to 10 mL. By adding 80% acetone, the light absorption of the filtrate was read at wavelengths of 663 and 645 nm using a Pyeuni/Cam spectrophotometer. The following relationships were used to calculate the amount of chlorophyll a, b, and the total (a+b):

$$Chl. a = [12.7 (D663) - 2.69 (D645)] \times V / (1000 \times W)$$

$$Chl. b = [22.9 (D645) - 4.68 (D663)] \times V / (1000 \times W)$$

$$Chl. a + b = [20.2 (A645) + 8.02 (A663)] \times V / (1000 \times W)$$

***NPK Estimation:** Plant samples were taken separately from both the vegetative parts and the grains. The samples were dried at 65°C for 48 hours, then ground and thoroughly mixed. A 0.2 g sample was taken and digested using concentrated sulfuric and perchloric acids. The samples were transferred to 100 ml bottles, and the volume was topped up with distilled water. The total concentration of elements in the vegetative part of plant was then determined. Potassium was measured using a flame photometer according to the method proposed by (17). Phosphorus was estimated using ammonium molybdate and

ascorbic acid using a photometer spectrometer at a wavelength of (882) nanometers, as stated in (19). Total nitrogen in grains and the vegetative part was estimated using a microKeldahl apparatus according to the method described by (18) (and shown in (19)). Percentage of sodium (%Na): The sodium content in the plant samples was estimated using a flame photometer according to the method described in (19).

*** Seed yield plant⁻¹ g:** Calculated from the yield of the seed weight of five plants per pot for the three replicates and extracting the average.

Data analysis: After collecting the data, it was analyzed using the statistical program (Minitab) and the average coefficients were compared using Duncan's multiple range test at a probability level of 0.05.

RESULTA AND DISCUSSION :

Total Chlorophyll Content

The numbers in table (1) show that the different variety showed a significant difference in their total chlorophyll content, as the Amal variety had the highest content reaching 2.20 mg g⁻¹ wet weight, compared to the Arifaat which gave 1.94 Mg .g⁻¹.

The data in the same table refer to significant difference between salin water concentrations on chlorophyll content, less value recorded when using 3000 ppm concentration reached 1.46 mg g⁻¹ compared with control treatment which gave high value reached 2.56 mg g⁻¹.

The same table data, show that the interaction between different varieties and different concentration from salin water had a significant effect on the content of

total chlorophyll in the leaves, amounting to 1.40 mg g⁻¹ when Rehaan variety irrigated with 3000 ppm salin water compared to plants of the Amal variety not treated with normal water. Which gave high value reached 2.80 mg g⁻¹. Salinity leads to water deficit, resulting in moisture stress that reduces chlorophyll content due to decreased chlorophyll pigments. This inhibits photosynthesis by limiting stomata, affecting chloroplast growth and thus reducing pigments, including chlorophyll pigments (23), also chlorophyll deficiency is attributed to the fact that humidity stress affects the activation and synthesis of hormones that inhibit chlorophyll synthesis, such as the abscisic hormone ABA, which leads to a decrease in the content of photosynthetic pigments

as a result of a decrease in cytochrome synthesis in the plant roots and a decrease

in its transfer to the shoot system.(24)

Table 1. Effect Vrieties and Salinity concentrations(ppm) on total chlorophyll content (mg g⁻¹ wet weight)

Variety Mean	Salinity Conc.(ppm)				
	0	1000	2000	3000	
Rehaan	2.60ab	2.10bc	1.70d	1.40e	1.94b
Arifaat	2.30b	2.00c	1.70d	1.30ef	1.82bc
Amal	2.80a	2.40b	1.90cd	1.70d	2.20a
Mean	2.56a	2.16b	1.76c	1.46d	

Nitrogen (%)

It is clear from the results of figure (1) that the varieties differed significantly in terms of Nitrogen content, with the Amal variety having plants that reached 2.42% with an increase of 24.10% compared to the Arifaat varieties, whose plants reached 1.95 %.

The same table results show that use of irrigation water with different salinity concentrations significantly affected Nitrogen percentag. The highest concentration, 3000 ppm, resulted in the lowest Nitrogen percentage reached 2.00% with a decrease rate of

45.52% compared to plants irrigated with tab water (control treatment), which contained higher percentage reached 2.65%.

The interaction between varieties and different concentration of salinity irrigation water showed a significant effect on the plant height. The interaction Amal variety and irrigated with normal water record hieght percentage 2.47% with an increase reached 65.77 compared with the Arifaat variety irrigated with 3000 ppm from salin water which recorded least value reached 1.49 %. Increasing the concentration of sodium chloride in the soil leads to an imbalance in the ion and causes cytotoxicity (25). The absorption of high amounts of sodium ions leads to a reduction in the absorption of Nitrogen,calcium, magnesium and potassium ions through the loss of the ability of roots to control ion absorption and the competition of ions for absorption sites in the root (26).

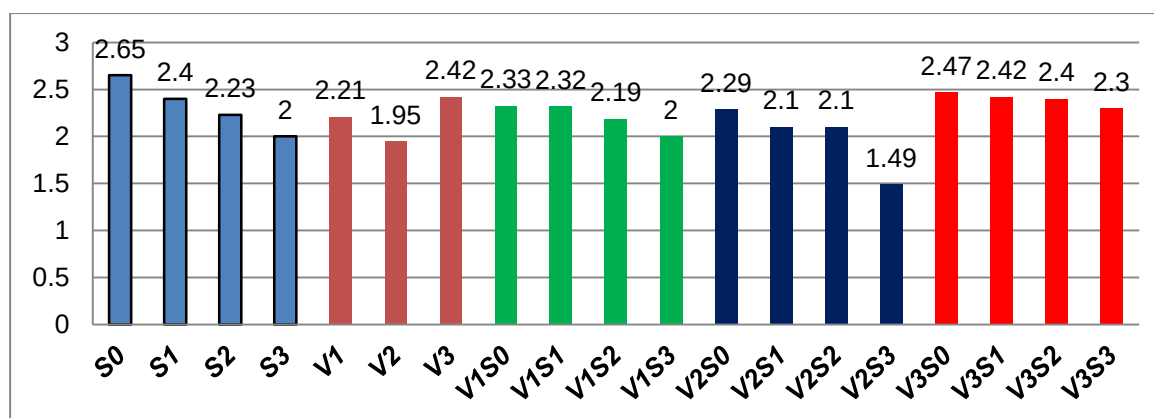


Figure (1) Effect the varieties and salinity levels of Irrigation water on Nitrogen Percentage (%).

Phosphor (%)

The figure (1) show that the varieties differed significantly in terms of phosphor content, with the Amal variety having higher percentage reached 0.42% with an increase of 55.17% compared to the Arifaat varieties, whose plants reached 0.29 %.

From the same table we see that use of irrigation water with different salinity concentrations significantly affected Phosphor percentag. The highest concentration 3000 ppm salinty of irrigated water resulted in the lowest Phosphor percentage reached 0.31% with a decrease rate of 26.19% compared to plants irrigated with tab water (control treatment), which contained higher percentage reached 0.42%.

The interaction between varieties and different concentration of salinity irrigation water showed a significant effect on the Nitrogen percentage on plant shoot. Irrigation Amal variety with normal water record hieght percentage reached 0.49% with an increase reached 122.72% compared with the Arifaat variety irrigated with 3000 ppm from salin water which recorded least value reached 0.22 %. Increasing the concentration of sodium chloride in the soil leads to an imbalance in the ion and causes cytotoxicity (25). The absorption of high amounts of sodium ions leads to a reduction in the absorption of another ions (26).

Figure (1) Effect the varieties and salinity levels of Irrigation water on Phosphor Percentage (%).

Potassium(%)

It is clear from the results of figure (1) that the varieties differed significantly in terms of Potassium content, with the Amal variety having highest percentahe reached 1.80 % with an increase of 11.11 % compared to the Arifaat varieties, whose plants reached 1.62 %.

The same table results show that use of irrigation water with different salinity concentrations significantly affected Phosphor percentag. The highest concentration, 3000 ppm of irrigation water resulted in the lowest Potassium percentage reached 1.62% with a decrease rate of 6.89 % compared to plants irrigated with tab water (control treatment), which contained higher percentage reached 1.74%.

The interaction between varieties and different concentration of salinity irrigation water showed a significant effect on the plant height. The interaction Amal variety and irrigated with normal water record hieght percentage 1.84 % with an increase reached 18.70 compared with the Arifaat variety irrigated with 3000 ppm from salin water which recorded least value reached 1.55%. An increase in the percentage of sodium chloride (Figure 4) leads to an increase in the salinity percentage, which leads to a disturbance of cellular balance by imposing osmotic stress, restricting the absorption of potassium (K^+) and promoting the excessive accumulation of sodium (Na^+) and chloride (Cl^-), which reduces the K^+ / Na^+ ratio and weakens metabolic processes (28).

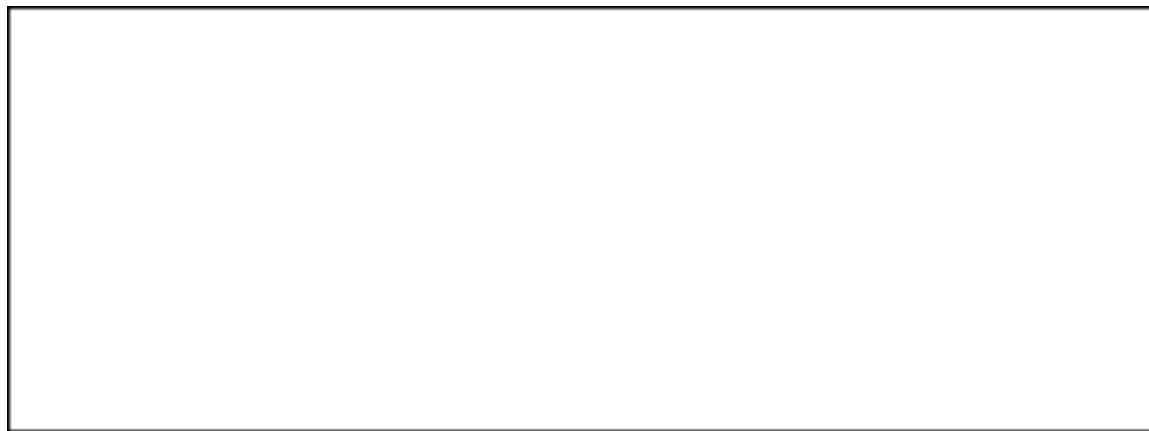


Figure (1) Effect the varieties and salinity levels of Irrigation water on Potassium Percentage (%).

Sodium (%) :

figure (1) refer that the varieties differed significantly in terms of Sodium content, with the Arifaat variety having high concentrate reached 0.22% with an increase of 22.22% compared to the Amal varieties, whose plants contained percentage reached 0.18 %.

From same table results see that use of irrigation water with different salinity concentrations significantly affected Sodium percentag. The highest concentration, 3000 ppm of salinty water, resulted in the lowest phosphor percentage reached 0.28 % with a increase rate of 115.38 % compared to plants irrigated with

tab water (control treatment), which contained least percentage reached 0.13%.

The interaction between varieties and different concentration of salinity irrigation water showed a significant effect on the plant height. The interaction Arifaat variety and irrigated with salinity water 3000 ppm concentration record highest percentage 0.32% with an increase reached %190.90 compared with the Amal

variety irrigated with normal water which recorded least value reached 0.11 %. Irrigation with saline water and soil salinity increases the concentration of sodium ions and decreases the concentration of potassium ions, as well as the rate of transpiration, the rate of photosynthesis, the concentration of carbon dioxide inside the stomata, and the chlorophyll content (table 1). (29).



Figure (1) Effect the varieties and salinity levels of Irrigation water on Sodium Percentage (%).

Plant Yield (gm)

Table (1) show that the different variety showed a significant difference in their seed yield, as the Amal variety had the highest yield reaching 4.97 gm with an increase reached 131.16% compared to the Arifaat which gave 2.15 gm..

The data in the same table refer to significant difference between salin water concentrations on seed yield plant⁻¹, least value recorded when using 3000 ppm concentration reached 0.57 gm plant⁻¹ compared with control treatment which gave high value reached 6.81 gm plant⁻¹..

The same table data, show that the interaction between different varieties and different concentration from salin water had a significant effect on the seed yield, amounting to 0.21 gm when Rehaan variety irrigated with 3000 ppm salin water compared to plants of the Amal variety not

treated with normal water. Which gave high value reached 8.22 gm. The disturbance in the ion content of plants affected by salinity has been attributed to a disruption in the normal functions of cell membranes, especially the plasma membrane. An increase in the concentration of sodium ions in the growth medium weakens cell membranes by displacing calcium from the membrane structure. Since calcium is essential for the integrity of cell membranes and the regulation of selective ion permeability, its displacement from cell membranes leads to an increase in their permeability and a disturbance in the ion content of the cells. This negatively affects the metabolic processes occurring in plant cells, leading to a decrease in growth rates this is reflected in the components of the harvest and the seed yield.(30),Also salt stress

leads to a decrease in the water potential of plant leaves, resulting in stomatal closure due to loss of turgor pressure. This decrease in turgor pressure leads to a reduction in carbon dioxide conduction, which in turn increases oxidative stress,

alters cell wall structure, and produces toxic metabolites, ultimately causing plant death. It also halts photosynthesis, resulting in stunted growth and reduced yield (31).

Table 4. Effect Vrieties and Salinity concentrations(ppm) on Flage leaf area (cm²).

Variety Mean	Salinity Conc.(ppm)				
	0	1000	2000	3000	
Rehaan	6.87c	4.29e	1.41g	0.65ij	3.31b
Arifaat	5.35d	2.70g	0.35j	0.21j	2.15c
Amal	8.22a	7.47b	3.34f	0.85i	4.97a
Mean	6.81a	4.82b	1.70c	0.57d	

Conclusion

The study results appeared that different concentrations of irrigation water salinity negatively affected all studied traits. The higher the salinity concentration, the greater the effect, and the varieties of

Hordeum Vulgare L. plants differed in elements content and seed yield, with the Amal variety outperforming the other varieties in this study.

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Informed consent

Experiment on plants, not animals.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the

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