Research Article

Study Of Growth Indicators And Protein Content Of Three Hordeum Vulgare L. Varieties Under Different Levels Of Salinity Irrigation Water

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Abstract

A field experiment 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 growth indicators and protein content of three barley varieties (Rihaan, Arifaat, and Amal) under different levels of slinity irrigation water (0, 1000, 2000, and 3000) parts per million (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 variety Amal excelled in plant height, number of tillers per plant, chlorophyll content, flag leaf area, relative leaf water content and prttein percentage by 56.75cm,8.87 tilliers plant^{-1}, 2.20mg gm^{-1} wet weight, 14.55cm2,74.50% and 8.85% repectively. Salinity levels significantly and negatively affected all studied traits, Irrigation with normal water(zero salinty) gave heighest values on same triats reached 45.00cm,7 tillier,2.36 mg gm^{-1}, 15.66cm^2, 80.90% and 8.36% respectively. The interaction between Amal variety and irrigation with normal water showed resulted in the highest values for the studied traits, reaching 67.00 cm, 10.0 tillers plant^{-1}, 2.80 mg/g total chlorophyll, 16.50 cm², 83.90% and 9.10% respectively.

Keywords: barley+salinity+Growth+protein

Introduction

Environmental stress encompasses several environmental conditions, whether individual or combined, that negatively impact plant growth, both developmentally and reproductively. These conditions include drought, salinity, and heat (Al-Ashram, 2018). Ideal living conditions for plants are rare, as they are frequently subjected to harsh conditions throughout their life cycle, such as water scarcity and excessive or insufficient irrigation intensity of light and significant rise and fall in temperatures. Exposure to these conditions causes stress in plants, which affects all vital physiological processes. Therefore, it is necessary to know the damage caused by these various stresses, as well as the mechanisms by which plants resist them, in order to address the problem (Jabour 2007).

The problem of salinity has begun to appear in recent years in the world and to a large extent as a result of drought in many countries of the world. With the increase in the world’s population and the increase in demand for food, the problem of salinity has emerged as one of the main problems that stand as an obstacle to increasing agricultural production, due to the direct negative effects it has on plants (toxicity or osmosis) or indirect effects on the physical and chemical properties of the soil (Al-Zubaidi, 1989).

There are many factors that contribute to the accumulation of salts in the soil, such as soil type and water movement through it, which plays a major role in the salt balance process, the depth and salinity of groundwater, the quality of water used for irrigation, the intrusion of seawater into groundwater in coastal areas, as well as dissolved salts added through the fertilization process, in addition to increasing the rate of evaporation, which leads to the accumulation of salts in the soil. Also, the amount of rainfall is not sufficient to wash away the salts that accumulate in the root zone of plants (Al-Saidi, 2005),this leads to many agricultural areas becoming unsuitable for cultivation each year, negatively impacting the growth of most crops, including barley. Using numerous newly developed or environmentally resistant varieties is one solution to overcome the problem of irrigation water and soil salinity.

Under certain climatic conditions, information relating to salinity and irrigation management, along with the interpretation and analysis of the salt tolerance limits of plant species, is essential for selecting the appropriate crop and variety for cultivation in agricultural areas where saline water is available for irrigation, in order to avoid salinization of these areas and ensure good commercial production (Francisco et al., 2017).Continuously identifying salt-tolerant varieties for cultivation in highly saline environments is crucial (Al-Duaiki and Zanin, 2024).

Barley (Hordeum vulgare L.) is a vital crop in the world, belonging to the grass family (Poaceae). It ranks fourth in economic importance after wheat, maize, and rice. In Iraq, it is the second most important crop after wheat (Naaser,2022,Essa et al.,2026). Barley is characterized by its high resistance to salinity and drought. Most regions of Iraq are suitable for its cultivation, especially the northern regions, which are considered one of the areas of origin for double-row barley. Barley has high nutritional value, as its grains contain, on average, 78% carbohydrates, 10% protein, 10% water, and 1% fat (Al-Baldawi et al., 2014).

Barley stands out from other crops due to its tolerance to a wide range of environmental stresses, such as salinity, cold, and drought (Qajo, 2014). Improved barley varieties are among the most important outcomes of plant breeding programs, with researchers focusing on developing varieties resistant to environmental stresses to meet the growing global demand for grains (FAO, 2021). Given the high economic importance of barley, it was chosen as the focus of this study in an attempt to address one of the problems facing agriculture, based on the role of universities and research centers in serving the community.

There are many factors that contribute significantly to increased plant productivity, including the selection of a suitable variety adapted to the region, which greatly increases crop yield. Barley varieties naturally vary in productivity due to genetic differences. Therefore, introducing new, high-yielding varieties increases production, improves quality, and reduces costs. Furthermore, selecting varieties appropriate to the region's conditions helps increase production and improve quality (Al-Abbar, 2021; Muhammad, 2021).

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

Materials and methods

The experiment was carried out 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 growth characteristics and protein content of three varieties of barley plants, namely (Raihaan, Arifaat, and Amal), 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 Black and Hartge (1986), electrical conductivity according to the method of Richard (1954), and pH according to the method of Black (1965), Phosphorus, potassium and calcium were estimated by the Flame Photometer, while total nitrogen was estimated using the microKjeldal device as described in (A.O.A.C, 1980). Organic matter was estimated by the loss by incineration method as described in (Page et al., 1982). Superphosphate P2O5 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:**

*** Plant height (cm):** Measured using a measuring tape from the soil surface to the top of the plant, excluding the ears.

*** Number of tillers per plant:** Measured for five plants per pot, and the average for each treatment was calculated.

*** Chlorophyll content (mg g^{-1} wet weight)**: Chlorophyll content in plant leaf tissues was determined according to the method described by Arnon (1949). 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):

$$\mathrm{Chl.a} = [12.7\ (\mathrm{D663}) - 2.69\ (\mathrm{D645})] \times \mathrm{V}/(1000 \times \mathrm{W})$$
$$\mathrm{Chl.b} = [22.9\ (\mathrm{D645}) - 4.68\ (\mathrm{D663})] \times \mathrm{V}/(1000 \times \mathrm{W})$$
$$\mathrm{Chl.a+b} = [\ 20.2\ (\ \mathrm{A645}\ ) + 8.02\ (\mathrm{A663})] \times \mathrm{V}/(1000 \times \mathrm{W}\ )$$

***Flag Leaf Area (cm²):** Calculated at 100% flowering, based on the average area of five flag leaves per pot, using the following equation:

Leaf Area (cm²) = Leaf Length (cm) × Leaf Width (cm) × 0.95 (Thomas, 1975)

***Relative Water Content (%):** Several wet leaves were taken at 100% flowering, placed in nylon bags to prevent moisture loss, weighed immediately after cutting, and then placed in distilled water for 12-14 hours under light and room temperature, the papers were dried using blotting paper and weighed. Then they were placed in an oven at 65°C for three hours and weighed again. The weight was measured according to the equation described by (Siddique et al. 2000).

Relative Water Content = FW – DW / TW – DW × 100

Where: FW = Fresh Weight (g), DW = Dry Weight (g), TW = Plump Weight (g)

* **Percentage of Protein in the Grains (%): (%Protein):**The nitrogen content in the seeds was estimated using a Microkhejldal analyzer, and then multiplied by a factor of 6.25 to obtain the protein content. The dried seeds were ground, and 4.0 g of the grain powder was taken from each experimental unit and placed in special bottles for digestion 10 ml of concentrated sulfuric acid was added and left for 24 hours. Then the samples were placed on a heat source and hydrogen peroxide was used to carry out the digestion process until the solution became clear and white, according to the method of

(Schuffelen et al., 1961). After the digestion process was completed, the nitrogen in the sample was estimated using a microkaldal apparatus, and then the protein percentage was calculated as follows:

Protein percentage(%) = Nitrogen percentage × 6.25 (Rastovski and Vanesetal 1987).

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

Plant height

It is clear from the results of table (1) that the varities differed significantly in terms of plant height, with the Amal variety having plants that reached 67 cm in height, compared to the Rehaan and Arifaat varieties, whose plants reached 52 and 51.75 cm respectively.

The same table results show that use of irrigation water with different salinity concentrations significantly affected plant height. The highest concentration, 3000 ppm, resulted in the lowest plant height of 45 cm, compared to plants irrigated with regular water (control treatment), which produced the highest plant height of 61 cm.

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 value reached 67 cm compared with the three variety irrigated with 3000 ppm from salin water which recorded least value reached 45 cm which did not differ in terms of between them morally. Salt stress reduces productivity and quality by affecting physiological, biochemical and photosynthetic processes (Kalehjoee et al., 2026 and Soni et al., 2023),also salinity affects plant growth, leading to a reduction in root and shoot length, fresh and dry weights, and leaf area. The effect of salinity on plant growth rates varies depending on the plant's sensitivity to salinity. The decrease in growth has been attributed to osmotic effects and the specific toxicity of ions as for osmotic effects, increased salinity in the growth medium leads to a decrease in the availability of water for absorption by the roots and this negatively affects the growth and height of the plant (Al-Rubaie, 2002).

Table 1. Effect Vrieties and Salinity concentrations(ppm) on plant height (cm).

Variety	Salinity Conc.(ppm)				Mean
	0	1000	2000	3000	
Rehaan	57.00c	56.00c	50.00e	45.00f	52.00b
Arifaat	59.00b	53.00d	50.00e	45.00f	51.75b
Amal	67.00a	60.00b	55.00cd	45.00f	56.75a
Mean	61.00a	56.33b	51.66c	45.00d	

Branches number

The results of table (1) show that the varities differed significantly on characteristics of plant height, Amal variety gave height value reached 8.87 branch compare to Rehaan which gave 7.37 branche.

From same table results appeared that use of irrigation water with different salinity concentrations significantly affected plant height. The highest concentration, 3000 ppm, resulted in the lowest plant branch reached 7 branch, compared to plants irrigated with regular water (control treatment), which produced the highest branch number reached 9.00 branch.

The interaction between varieties and different concentration of salinity irrigation water showed a significant effect on the number of branches. The interaction Amal variety and irrigated with normal water record hieghest value reached 10.00 branch compared with the Rehan variety irrigated with 3000 ppm from salin water which recorded least value reached 7.00 branch which did not differ in terms of between them morally. The moisture stress resulting from soil salinity led to a decrease in the number of tillers. This reduction in tiller number due to moisture stress may be attributed to the failure or delay of tiller emergence from lateral bud nodes at the beginning of their development, and to the inhibition of the growth and development of crown roots, which are crucial for tiller formation and development (Hucl and Bakerm, 1989).

Table 2. Effect Vrieties and Salinity concentrations(ppm) on number f branches plant^{-1}.

Variety	Salinity Conc.(ppm)				Mean
	0	1000	2000	3000	
Rehaan	8.00d	8.00d	7.50e	6.00g	7.37bc
Arifaat	8.50c	8.00d	7.50e	7.00f	7.75b

Amal	10.00a	9.00b	9.00b	7.50e	8.87a
Mean	9.00a	8.33ab	8.00ab	7.00b	

Total Chlorophyll Content

The numbers in table 3 show that the different variety showed a significantaly 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 diffrence between salin water concentrations on chlorophyll content,leas value recorded when using 3000 pom concentration reached 1.46 mg g^{-1} compared with control treatment which gave heigh 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 heigh value reached 2.80 mg gm^{-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 (Ludlow et al., 1990).
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.(Saqar,2009)

Table 3. Effect Vrieties and Salinity concentrations(ppm) on total chlorophyll content (mg g^{-1} wet weight)

Variety	Salinity Conc.(ppm)				Mean
	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	

Flag leaf Area

Not from the results of table (4) that Amal variety gaved high value of flag leave area reached 14.55 cm^2 while the varieties Arifaat recorded least value reached 12.33 cm^2.
The different concentration from salin water showed a positive significant effect, in which the concentration 1000 ppm gave the least value reached 11.40 cm^2 compared control treatment which gave heigheast value reached 15.16 cm^2.
The interaction between varieties and salin water concenration affected significantly on flag leaf area,the variety Amal irrigated with normal water gave high value reached 16.50 cm^2 compared with variety Rrhaan iriigated with salin water 3000 ppm which gave least value reached 12.00 cm^2. The reason for the decrease in leaf area as a result of treatment with different concentrations of salinity is attributed to the occurrence of moisture stress in the plant, which leads to a decrease in the relative water content (Table 5) of the plant, which leads to a decrease in the growth rate of the vegetative parts. Water plays an important role in the process of cell division and elongation, the availability of nutrients in the soil, and the ease of their absorption. Consequently, the process of photosynthesis decreases, which in turn leads to a decrease in leaf area (Hsaio, 1973).and increasing salt concentrations in the plant leads to hindering vital processes in the plant, especially division and elongation, which causes a reduction in the area of the flag leaf (Al-Ubaidi, 2006).

Table 4. Effect Vrieties and Salinity concentrations(ppm) on Flage leaf area (cm^2).

Variety	Salinity Conc.(ppm)				Mean
	0	**1000**	**2000**	**3000**	
Rehaan	15.00bc	14.80bc	12.10e	12.00e	13.47b
Arifaat	14.00c	13.00d	12.30de	10.00f	12.33c
Amal	16.50a	15.50b	14.00c	12.20df	14.55a
Mean	15.16a	14.43b	12.80c	11.40d	

Realative Water Content

The data on the table (5) showed that Amal variety gaved high value of relative water content by 74.50 % while the varieties Rehaan recorded least value by 66.20 %.
The different concentration of salin water showed a positive significant effect, in which the concentration 3000 ppm gave the least value 56.70 % compared control treatment which gave heighest value by 80.90 %.
The interaction between varieties and salin concenration affected significantly on relative water content,the variety Rehaan irrigated with 3000 ppm gave lowh value by 51.30% compared with variety Amal untreated with salin water which gave height value by 83.90%. The negative effects of salt stress on membrane stability and root water absorption: Increased membrane permeability and electrolyte leakage under saline conditions weaken cell hydration, which explains the significant decrease in relative water content. (Murtdha, 2026). As for osmotic effects, increased salinity in the growth medium leads to a decrease in the availability of water for absorption by the roots (Al-Rubaie, 2002).

Table 5. Effect Vrieties and Salinity concentrations(ppm) on Water relative content (%).

Variety	Salinity Conc.(ppm)				Mean
	0	1000	2000	3000	
Rehaan	78.80c	72.11d	62.60f	51.30i	66.20c
Arefaat	80.00b	76.10c	68.10e	58.80h	70.75b
Amal	83.90a	82.10ab	72.30c	60.0d	74.57a
Mean	80.90a	76.77b	67.66c	56.70d	

Protein Content
Table (6) show that Amal variety gaved high percentage of protein by 8.96%, while the varieties Rehaan recorded least percentage by 7.03%.
The different concentration salin water showed significant effect on protein percentage, in which plant irrigated with normal water gave the highest percentage by 8.36% compared to plants irrigated with 3000 ppm which gave least percentage by 7.15%.
The interaction between varieties and different salin concentration affected significantly on protein percentage,the variety Amal irrigated with normal water gave high percentage by 9.10 % compared with variety Rehaan irrigated with 3000 ppm which gave least by 5.60 %. One of the biological processes affected by salinity is protein synthesis. It has been found that increasing salinity concentrations in the growth medium leads to a decrease in protein levels in crop plants.
Salinity reduces the rate of protein synthesis by affecting the cellular content of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA). High salinity concentrations cause a decrease in their proportions within the cells,the decrease in protein content at high salinity concentrations has been attributed to the effect of salinity on the content of amino acids in cells. It has been found that salinity affects the absorption of some essential mineral elements (such as nitrogen, phosphorus, and sulfur) necessary for the synthesis of amino acids (Al-Rubaie, 2002).

Table 6. Effect Vrieties and Salinity concentrations(ppm) on Protein percentage (%).

Variety	Salinity Conc.(ppm)				Mean
	0	1000	2000	3000	
Rehaan	8.00d	7.50e	7.00f	5.60	7.03c
Arifaat	8.00d	7.90de	7.50e	7.00f	7.60b
Amal	9.10a	9.00ab	8.90ab	8.85c	8.96a
Mean	8.36a	8.13b	7.80c	7.15d	

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 growth characteristics and protein percentage on grain,with the Amal varaiety outperforming the outher varaieties in this study.

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Informed consent
Experement on plants,not animals.

Confilict of interest

The authors declare that there are no confilicts of interest regardind the publication of this article.No funding or sponosrship influnced the design of the study ,data collection ,analysis ,decision,or preparation of the manuscript.

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