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The Effect of Irrigation Water Type on Germination Percentage and Morphological Characteristics of Wheat, *Triticum Aestivum* and Barley, *Hordeum Vulgare*

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ABSTRACT

An experiment was conducted in plastic pots in an open place in Salah El-Din / Samarra during the winter season 2020/2021 on wheat, Triticum aestivum L. (Sham 6) and barley, Hordeum vulgare L. (Arabic white). The purpose is to find out the effect of the type of irrigation water (river water and well water) on the percentage of germination and morphological characteristics of three growth stages: seedling, vegetative growth and flowering in wheat and barley plants. The results showed that irrigation with well water caused a significant decrease in the percentage of germination in wheat compared to irrigation with river water, while irrigation with well water caused a non-significant increase in the percentage of germination in barley compared to irrigation with river water. In the seedling stage: the cause of irrigation with well water was a significant decrease in the two characteristics of root length and plant length in wheat. While it caused a significant decrease in plant length and leaf area in barley. In the vegetative growth stage: the well water caused a significant increase in the characteristics of root length, stem length and plant length in wheat and barley plants. In the flowering stage: the well water caused a significant decrease in all morphological characteristics of the wheat plant. While irrigation with well water caused a significant decrease in the characteristics of root length, plant length and leaf area in barley.

Introduction

Wheat occupies the first place among cereal crops in terms of economic importance and cultivated area globally [1]. Wheat germ oil, gluten and wheat starch are included in food industrial applications [2]. Barley (*Hordium vulgare* L.) is the fourth important cereal crop in the Poaceae family (Gramineae), which is widely cultivated in saline regions [3]. Barley is used as fodder for livestock and poultry in the form of grain, hay, or green fodder [4]. Cereal crops are grown in most regions of the world, so they are exposed to various environmental stresses that affect their growth and grain yield. Abiotic stresses including salinity, drought, nutrient deficiencies, waterlogging, cold and heat have become major agricultural threats due to global warming and significantly reduce field crop productivity [5,6]. Excess salinity causes morphological, anatomical, and physiological changes at the level of cells, tissues, and organs [7, 8]. Salinity stress plays a major role in reducing crop yield [9]. It negatively affects the various stages of growth and unfolding, such as germination, the beginning of the seedling stage, vegetative growth, and the date of flowering and fruiting [10]. And the effect of salinity on growth and productivity depends on soil composition, type and concentration of salts, cultivar and environmental conditions [11]. [12] indicated that seedlings are very sensitive to stress conditions, and seedling death occurs due to salinity stress. Increasing the level of salt concentrations negatively affects root length and its ability to absorb water [13]. Due to the importance of water in plant life, this study aimed to show the effect of the type of irrigation water on the percentage of germination and morphological characteristics of wheat and barley plants.

Materials and methods:

1- Implementation and design of the experiment:

This study was conducted in an open place in Samarra / Salah Al-Din Governorate during the winter season 2020/2021 on wheat, *Triticum aestivum* L. (Sham 6) and barley, *Hordeum vulgare* L. (Arabic White), in plastic pots, the length of the pot is 25 cm. Its end diameter is 26 cm, as each growth stage includes five replicates per treatment. The seeds were obtained from the General Authority for Seed Examination and Certification in Salah Al-Din / Tikrit / Al-Zuhur Street. As the pots were prepared with soil taken from one of the fields in the city of Samarra, and its physical and chemical characteristics were analyzed, Table 1, and urea fertilizer and triple superphosphate were added by mixing it with the soil and according to the recommendations. As 15 seeds were planted in each pot, two types of water were used to irrigate the plants: river water and well water. After 14 days of planting, the percentage of germination of the seeds was calculated. After 24 days of cultivation, the plants were thinned to seven plants per pot.

The experiment included two factors, river water and well water. It was applied to wheat and barley plants. The experiment was conducted on three growth stages: seedling stage, vegetative growth and flowering. Thus, the total number of transactions becomes 12, and each growth stage contains 5 replicates for one treatment.

2- The characteristics studied:

A- Germination percentage:

The percentage of seed germination for each pot was measured fourteen days after planting the seeds according to the following equation [14]:

$$\text{Germination percentage}=\frac{\text{the number of germinated seeds}}{\text{the number of seeds planted}} *100\%$$

Table 1: The physical and chemical characteristics of the soil used in the research.

Characters	Value
EC (mmhos)	2.76
PH	7.61
N available (ppm)	44
P available (ppm)	10
K available (ppm)	142
Organic mater %	1.22
total $CaCO_3$%	22
total $CaSO_4$%	13
Sand%	37
Silt%	48
Clay%	15
Texture	loam

B- Morphological characteristics:

- Root length (cm): The length of the root was measured from its tip to its connection point with the stem for five plants and the average was extracted.
- Stem length (cm): The length of the stem from its connection point to the root to its apex was measured for five plants and the average was extracted.
- Plant length (cm) The length of the plant was measured from the tip of the root to the end of the stem for five plants and the average was extracted.
- Leaf area (cm^2/plant): The average leaf area was measured for five plants through the following equation:

Paper area = paper length * maximum width * 0.95.

3- Statistical analysis:

The results of the research were analyzed statistically by applying the Minitab program according to the ANOVA test, and the arithmetic means were compared according to the Dunkin's multiple range test at the level of probability $p \leq 0.05$ [15].

Results and discussion

1- The effect of the type of irrigation water on the percentage of germination of wheat and barley plants:

It appears from the results, Figure 1, that irrigation with well water caused a significant decrease in the percentage of germination in the wheat plant, as it reached 93.0% compared to irrigation with river water, which amounted to 96.0%, while irrigation with well water caused a non-significant increase in the percentage of germination in the barley plant, as it reached 98.0% compared to irrigation with river water, which amounted to 97.3%. The results of these results agree with what was reached by [16], as it was shown that there was a significant decrease in the percentage of total germination of wheat seeds at salinity levels (16-20 dS/m). It agrees with [17], which showed that increasing NaCl concentrations led to a decrease in germination levels in wheat cultivars. It did not agree with [18], as the percentage of germination decreased in barley plant in response to salinity stress. Explain [19] the reason for failure or delay in germination in high salt media is the high osmotic pressure of the soil solution, and that the accumulation of sodium ions inside the seed will affect the vital activities of the embryo. Increasing salinity in the medium of plant growth also leads to a decrease and delay in germination with a lengthening of the time period necessary for the completion of germination [20]. As the salts raise the osmotic pressure of the growth medium, which leads to a decrease in the amount of water facilitated for absorption by the seeds, and the seed does not obtain a sufficient amount of water required for germination, and this causes failure or delay in germination [21].

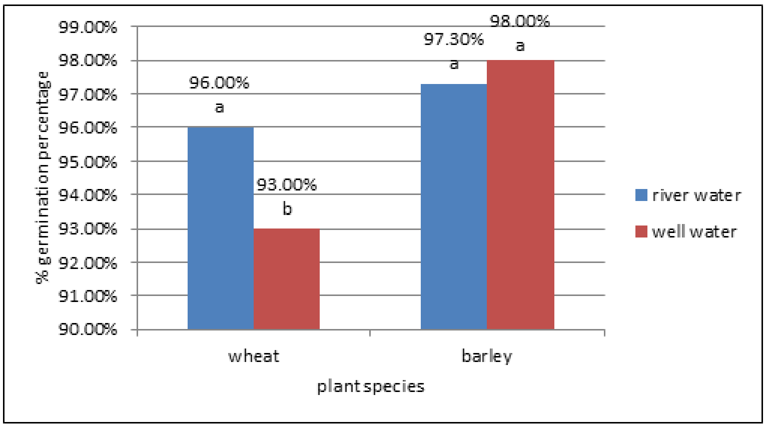

Figure 1: Effect of irrigation water type on germination percentage (%) of wheat and barley plants

2- The effect of irrigation water type on the morphological characteristics of wheat and barley plants:

It appears from the results, Table 2, that irrigation with well water caused a decrease in most of the morphological characteristics of wheat plants in the seedling stage, and the differences were significant in the two characteristics of root length and plant length, they were 3.86 cm and 5.60 cm, respectively, compared to river water, which gave the highest rates for these characteristics, which were 4.98 cm and 6.72 cm, respectively, while there were no significant differences between the two types of water for the rest of the characteristics, as the length of the stem was equal for both types of water, which amounted to 1.74 cm, while the leaf area reached 2.13 cm^2 when irrigating with well water, while it reached 2.17 cm^2 when irrigating with river water.

As for the barley plant, irrigation with well water caused a decrease in all morphological characteristics of the plant at the seedling stage, and the differences were significant in the two characteristics of plant length and leaf area, which were 5.98 cm and 2.88 cm^2, respectively, compared to irrigation with river water, which gave higher rates for the two characteristics of plant length and leaf area, which reached 7.10 cm and 3.488 cm^2, respectively, while there were no significant differences between the two types of water for the characteristics of root length and stem length, reaching 4.58 cm and 1.40 cm when irrigating with well water, compared to 5.12 cm and 1.98 cm when irrigating with river water, respectively.

As it appears from the results, irrigation with well water was superior in all morphological characteristics of wheat plants in the vegetative growth stage, and the differences were significant for the characteristics of root length, stem length and plant length, it reached 9.02 cm, 21.4 cm, and 30.42 cm, respectively, compared to irrigation with river water, which gave the lowest rates for the characteristics of root length, stem length, and plant length, which amounted to 6.84 cm, 14.38 cm and 19.14 cm, respectively, while the difference was not significant between the two types of water due to the leaf area, as it reached 6.39 cm^2 at the well water compared to 5.49 cm^2 at the river water.

As for the barley plant, irrigation with well water caused an increase in most of the morphological characteristics of the plant in the vegetative growth stage, as it caused significant differences in the characteristics of root length, stem length and plant length, they were 11.1 cm, 13.24 cm, and 24.34 cm, respectively, compared to irrigation with river water, which gave the lowest rates for root length, stem length, and plant length, which reached 8.82 cm, 8.60 cm, and 17.42 cm, respectively, while the leaf area decreased significantly when irrigated with well water, reaching 9.76 cm^2 compared to 10.218 cm^2 when irrigating with river water.

It also turns out that irrigation with well water caused a significant decrease in all morphological characteristics of wheat plants at the flowering stage, reaching 9.35 cm, 28.67 cm, 38.03 cm and 9.91 cm^2 for root length, stem length, plant length, and leaf area, respectively, compared to river water, which gave the highest rates, they were 10.34 cm, 38.70 cm, 49.04 cm and 10.41 cm^2 for the characteristics of root length, stem length, plant length and leaf area, respectively.

In the barley plant, irrigation with well water caused a decrease in all morphological characteristics of the plant in the flowering stage, and the differences were significant for the root length, plant length and leaf area, which were 9.62 cm, 35.74 cm, and 7.33 cm^2, respectively, compared to irrigation with river water, which gave the highest rates of root length, plant length, and leaf area, which were 8.20 cm, 31.36 cm, and 4.57 cm^2, respectively, while the decrease was insignificant in stem length of 23.16 cm compared to 26.12 cm when irrigated with river water.

The results agree with [12] in his study on wheat plant and with [22] in his study on barley plant, as the salt stress had a negative effect on the length of the roots. The results also agree with what was reached by [23] in his study on wheat plant and with [22] in his study on barley plant that salinity reduces plant height. It also agrees with what was reached by [22, 24], as the increase in the salinity of the irrigation water caused a decrease in the area of the flag leaf.

Table 2: Effect of irrigation water type on morphological characteristics of wheat and barley plants

characteristics		root length (cm)		stem length (cm)		plant length (cm)		leaf area (cm^2)	
growing stages	irrigation water / type plant species	river water	well water	river water	well water	river water	well water	river water	well water
Seedlings	Wheat	4.98 a	3.86 b	1.74 a	1.74 a	6.72 a	5.60 b	2.17 c	2.13 c
	barley	5.12 a	4.58 ab	1.98 a	1.40 a	7.10 a	5.98 b	3.488 a	2.88 b
vegetative growth	Wheat	6.84 c	9.02 b	14.38 b	21.4 a	19.14 c	30.42 a	5.49 c	6.39 c
	barley	8.82 b	11.1 a	8.60 c	13.24 b	17.42 c	24.34 b	10.218 a	9.76 b
flowering	wheat	10.34 a	9.35 b	38.70 a	28.67 b	49.04 a	38.03 b	10.41 a	9.91 b
	barley	9.62 b	8.20 c	26.12 bc	23.16 c	35.74 c	31.36 d	7.33 c	4.57 d

*Numbers with the same letter mean that there are no significant differences between them according to Dunkin's multiple range test at the 5% probability level.

It is clear from the results of this study that the well water negatively affected the studied characteristics in the seedling and flowering stages and for both plants. There is a direct relationship between root length and vegetative growth. In the seedling and flowering stages, the root length decreased when irrigated with well water, and this was reflected on the vegetative characteristics, as stem length, plant length and leaf area decreased when irrigated with well water for both plants. In the vegetative growth stage, the root length increased, and this reflected positively on the vegetative characteristics. Root length and vegetative part are the most important characteristics of salinity tolerance because the roots have direct contact with the soil and absorb water and nutrients from the soil. Therefore, the root length provides an important indicator of the plant's salinity tolerance [25]. Decreased growth under salinity stress may also be attributed to reduced water potential, reduced photosynthesis [26,27,28], toxicity of ions [29], and disturbance in mineral uptake [27]. [30] also indicated that salinity affects vegetative growth as a result of the lack of water absorption by plants or the toxic effect of some ions such as Na^+ and Cl^-, which often slows down growth and slows down or stops meristematic activity, and plants remain short below the normal limit. Growth restriction can save energy expenditure, reduce ROS production, reducing the demand for protein-building amino acids, thus providing more free amino acids for osmotic modulation [31] and osmotic modulation is an effective component of salinity tolerance because it contributes to the maintenance of turgor and cell volume [32].

Conclusions:

It is clear from the results of the study that irrigation with well water negatively affected the percentage of germination in wheat plants, as the percentage of germination decreased significantly when irrigated with well water compared to irrigation with river water. While the well water had a somewhat positive effect on the percentage of germination in the barley plant, as it increased non-significantly when irrigated with well water. The well water also caused a decrease in the morphological characteristics in the seedling and flowering stages of both plants, while it caused an increase in the morphological characteristics in the vegetative growth stage of both plants.

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