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EFFECT OF IRRIGATION WATER QUALITY AND NITROGEN FERTILIZER IN THE GROWTH OF BARLEY CROP (*HORDEUM VULGARE* L.) AND SOME PHYSICAL AND CHEMICAL SOIL TRAITS IN DHI QAR PROVINCE, SOUTHERN IRAQ

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Abstract

In order to study the effect of the quality of irrigation water (River water of Al-Rifai and Suq Al-Shuyukh) and nitrogen fertilizer, an flowerpot experiment was conducted in the plastic house, Department of Soil Science, College of Agriculture using The Randomized Complete Block Design (RCBD), with three replicates. Silty loam soil was used by placing 10 kg soil per flowerpot and soil samples were taken for analysis. The nitrogen fertilizer of urea fertilizer was added at three levels (0.08, 0.16, 0.24 g N.10 kg^{-1} soil), add (0.8 g P.10 kg^{-1} of soil) of calcium superphosphate and (0.6 g K.10 kg^{-1} soil) of potassium sulfate before cultivating to all treatments. Fifteen seeds of barley plant were cultivated which thinning to ten plants per flowerpot after germination. Plants were harvested at maturity and dried, total dry weight, grain yield and plant height were estimated. Soil samples were taken after the harvest for analysis. Results of the study showed the following:

1) The use of Suq Al-Shuyukh water (6.0 $ds.m^{-1}$) led to a significant decrease in the total weight of dry matter, grain yield and plant lengths (33.5, 11.57, 54.74%), respectively compared to the treatments that irrigated with Al-Rifai river water (1.5 $ds.m^{-1}$).
2) Nitrogen has affected a significant effect on the total weight of dry matter, grain yield and length of plants. While the quality of irrigation water with nitrogen significantly affected in increase the total weight of the dry matter, grain yield and plant lengths (39.15, 16.31, 69.95%) respectively.
3) The use of Suq Al-Shuyukh water was significantly affected in the increase the degree of electrical conductivity and the percentage of adsorbed and exchanged sodium in the soil (3.58, 2.61, 2.57), respectively. While it led to significant reduce in the pH of soil with ratio of (7.71%).
4) Nitrogen has significantly affected in the reduce the electrical conductivity and soil interaction (2.64, 7.6%), respectively. While it led to significant increasing in the percentage of adsorbed and exchanged sodium in the soil (2.7, 2.53), respectively.

Key words **:** Irrigation, *Hordeum vulgare* L., Soil traits, Southern Iraq

Introduction

In spite of the progress made in water use techniques in agriculture, However, the population increase represented by geometric progression and horizontal expansion in agriculture to meet food needs is offset by relative stability in fresh water and arable land, especially in dry and semi-dry regions. This led researchers and farmers to use poor quality water in irrigation, which requires good soil and water management For the purpose of obtaining economic productivity (Abdelhalim, 1982).The used water in agriculture accounted for 90% of fresh water at the beginning of the last century and fell to 62% at its end (Abdel-Dayem, 2001).Nitrogen is one of the necessary and essential nutrients needed by the plant in its various growth stages. It enters the building of protoplasm, proteins, enzymes, and their accompanying such as NADH2, NADPH2, ATP and others. It also enters the composition of some vitamins, especially vitamin B complex, such as B1, B2, B6 and B12. In addition, it is included in the formation of vitamin H (Biotin), as well as in thiamin vitamin (Nicotinic acid) and some plant growth regulators (Auxins, cytokinins) and alkaloids. Nitrogen also enters the formation of the chlorophyll molecule, so it is important in the photosynthesis process, as well as its importance in the respiration process and plant access to the energy necessary to conduct or manage all vital events occurring in the plant (Abu Dhahi and Al-Yunis, 1988; Al-Naimi, 1990). Barley is one of the most important crops in the world. It is the fourth most important grain crop in terms of economic importance after wheat, rice and yellow corn. It is considered one of the most productive crops in the dry and semi-arid regions. It is the most productive grain crop in low water areas where it remains

alternative for wheat in low rainfall (Rili *et al*., 2010). Due to the low productivity of some agricultural crops in Dhi Qar province, which is located in southern Iraq, which may be attributed to the quality of irrigation water used to irrigate these crops or the nature of the soil and its characteristics, Therefore, this study, which aims to know:

1- Effect of the quality of irrigation water and nitrogen in the growth of barley plant and its components.

2- Effect of the quality of irrigation water and nitrogen in some physical and chemical properties of soil.

Materials and Methods

The study was conducted in the plastic house belonging to Department of Soil Science, College of Agriculture, Sumer University in the summer season (2017-2018), used in it a plastic Flowerpot of 10 kg of soil, a soil with a texture of Silty loam was brought from the surface layer (0-30 cm) for one field in Al-Rifai region, northern of Dhi Qar, southern Iraq. The soil was dried in air, smoothed and passed from a 4 mm diameter sieve, well blended to homogenize, a 10 kg of soil was placed in each flowerpot, Table (1) showed some of its traits. The seeds of barley were cultivated on 25-11-2017 with rate of 15 seeds per flowerpot, thinned after 2 weeks to 10 plants. The study included the use of three levels of nitrogen fertilizer (0.08, 0.16, 0.24 g N 10 kg soil) which is symbolized by (N1, N2, N3), respectively, in addition to the control treatment of N0, it was added in three batches, the first one after a week of cultivating and the second after three weeks of the first batch and the third at The stage of expulsion of inflorescences. The triple superphosphate fertilizer (20% P), with ratio of (0.8 gP. 10 kg^{-1} soil) and potassium sulphate fertilizer (41.5% K), with ratio of (0.6 g.10 kg^{-1} soil) were added in one batch before cultivating. Two types of water were used to irrigate the crop: the River water of Suq Al-Shuyukh which is symbolized by S1, and the River water of Al-Rifai which is symbolized by S2 after some chemical analysis. Water brought from their two sources by a plastic containers and taking water from the middle of the river (Gupta, 1985). Table (2) shows some of its traits. The irrigation is based on the Weighted method to make the soil moisture within the field capacity when losing (50-60%) of the availability water. A completely randomized design (CRD) was used (Steel and Torrie, 1960), with three replicates and the number of experimental units became 4 × 2 × 3 = 24 experimental units.

Plant Analysis

The plants were harvested to take the required measurements such as plant height, grain yield and total weight of dry matter.

Table 1: Some chemical and physical traits of soil before cultivating

Traits		Value	Units
Soil reaction degree (pH)		7.7	
Electrical conductivity		7.3	$ds.m^{-1}$
Positive ions	Calcium	5.4	$mmol.L^{-1}$
	magnesium	4.5	
	Sodium	14.3	
	Potassium	0.6	
Negative ions	Carbonates	-	
	Bicarbonates	4.2	
	Sulfates	12.2	
	Chloride	8.4	
Availability elements	Nitrates	8.4	$mg.kg^{-1}$
	ammonium	10.6	
	Phosphorus	6.3	
	Potassium	224.5	
	Calcium	445.0	
	magnesium	126.1	
Organic matter		11.9	$g.kg^{-1}$
Apparent density		1366	$Kg.m^{-3}$
exchange capacity of positive ions		28.2	$cmol.kg^{-1}$
Texture (silty loam)	Sand	381.68	$g.kg^{-1}$
	Silt	550.07	
	Clay	68.25	

Table 2: Chemical Analysis of Used Irrigation Water

Traits	River water of Al-Rifai	River water of Suq Al-Shuyukh	Units
Electrical conductivity	1.5	6.0	$ds.m^{-1}$
Soil reaction degree (pH)	7.3	7.6	
Positive ions			
Calcium	5.0	6.6	$mmol.L^{-1}$
magnesium	2.1	3.8	
Sodium	3.8	9.8	
Potassium	0.07	0.15	
Chloride	6	13	
Sulfates	2	4.3	
Carbonates	-	-	
Bicarbonates	2	3.2	

Results and Discussion

Effect of the quality of irrigation water and nitrogen in the total weight of dry matter

The results of the statistical analysis indicated that there was a significant effect on the quality of the irrigation water and nitrogen and their interaction between them in the total weight of the dry matter of the barley crop as shown in Table (1). The irrigation with Suq Al-Shuyukh river water led to a decrease of this trait, with ratio of (29.1 g.flowerpot^{-1}) compared to the irrigated treatments with Al-Rifai river water. While the addition of the second and third levels of nitrogen fertilizer led to increase the total weight of the dry matter of (34.6, 36.7 g.flowerpot^{-1}), respectively compared to the control treatment. While the interaction treatment between the third level of nitrogen fertilizer with Al-Rifai river water (S2N3) achieved the highest increase in this trait amounted of (41.6 g.flowerpot^{-1}) on the interaction treatment between the first level of nitrogen fertilizer with Suq Al-Shuyukh river water (S1.N1).

Table 3: Effect of the quality of irrigation water and nitrogen in the total weight of the dry matter of barley plant (g.flowerpot^{-1})

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	29.1	31.8	34.6	36.7	33.05	**0.104**
S_2	32.9	38.3	40.2	41.6	38.25	
Average	**31**	**35.05**	**37.4**	**39.15**		
L.S.D 0.05 N	**0.128**					
L.S.D S x N	**0.179**					

The decrease in the total weight of the dry matter of the barley crop when irrigation with Suq Al-Shuyukh river water may be due to the increased salinity of this water compared to Al-Rifai river water, which led to the imbalance of food and absorption of nutrient elements, which led to a decrease in the total weight of dry matter. This result agrees with (Ayeres and Westcot, 1985; Alwan *et al*., 1991; Al-Tai, 2000; Al-Hamdani, 2001; Shukri, 2002). Who found a decrease in the dry matter of the plant with increasing salinity of irrigation water. The increase in the total weight of the dry matter for the barley crop with nitrogen increase may due to increased nitrogen absorption in the soil, which increased its absorption by the plant and encouraged the cellular division and increased the size of the plant cell. This was reflected in the increase of the vegetation and the spread and expansion of the roots. This results agree with (Coaldrake and Pearson, 1985; Ouker *et al*., 1996) who obtained an increase in the dry barley content of the barley crop by increasing the added nitrogen.

Grain Yield

The effect of the quality of irrigation water and nitrogen has a significant effect on the barley grain yield, While the interaction between them did not have a significant effect in this trait, as shown that by the results of the statistical analysis as shown in Table (4). The weight of grains in the irrigated treatment with Suq Al-Shuyukh water was reduced by ratio of (9.22 g.flowerpot^{-1}) for the treatments irrigated with Al-Rifai river water. The second and third levels of the nitrogen fertilizer has excelled on the first level, with ratio of (12.20, 14.76 g.flowerpot^{-1}), respectively.

Table 4: Effect of the quality of irrigation water and nitrogen in the barley grain yield (g.flowerpot^{-1})

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	9.22	10.09	12.20	14.76	33.05	**0.285**
S_2	10.33	12.80	14.04	17.86	38.25	
Average	**9.77**	**11.45**	**13.12**	**16.31**		
L.S.D 0.05 N	**0.354**					
L.S.D S x N	**NS**					

The decrease in the weight of barley grain when irrigated with Suq Al-Shuyukh river water may be due to the increase in salinity of this water compared to Al-Rifai river water, which caused a decrease in the availability of water for plants although its availability with suitable quantities, as well as the effect of salinity in some chemical and physical traits of soil, Which was reflected in the growth of plants in terms of reduced nutrient elements availability , which led to a reduction in grain weight. The increase in grain weight with increasing nitrogen may due to the increase in the number of grains per spike and to the increase in the number of spikes per flowerpot and the increase in the number of branches, This results agree with (Anderson, 1990; Bationo, 1990; Sharma, 1999; Bacci *et al*., 1999; Al-Saadi, 2000) where they observed an increase in barley grains yield by increasing the amount of added nitrogen fertilizer.

Plant Lengths

The results of the statistical analysis indicate that the quality of irrigation water and nitrogen and their interaction have a significant effect on the lengths of barley plants estimated in centimeters as shown in Table (5). The irrigation with Suq Al-Shuyukh river water led to a reduction of this trait, with ratio 45.70 cm compared to the irrigation with Al-Rifai river water. While the percentage of increase in the second and third levels of nitrogen fertilizer were (56.76, 68.95), respectively compared to the first level. The interaction treatment between the irrigation with Al-Rifai river water and the third level of S2N3 nitrogen fertilizer achieved the

highest increase in plant lengths 70.95 cm compared to the interaction treatment between the irrigation with Suq Al-Shuyukh river water and the first level of nitrogen fertilizer S1N0.

Table 5: Effect of the quality of irrigation water and nitrogen in the Plant lengths of barley crop (cm)

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	45.70	47.56	56.76	68.95	54.74	**1.046**
S_2	49.65	51.13	63.87	70.95	58.9	
Average	**47.68**	**49.35**	**60.32**	**69.95**		
L.S.D 0.05 N	**1.278**					
L.S.D S x N	**1.812**					

The decrease in the length of plants when irrigated with Suq Al-Shuyukh river water may be due to the salinity of irrigation water in the process of absorption of water and nutrient elements, which led to a decline in plant lengths (Bourseir *et al*., 1987). This results agree with (Hammadi *et al*., 2002; Faraj *et al*., 2002) who found a decrease in the rate of the length of the plants irrigated with salty water. The increase in the length of barley plants with increase the averages of nitrogen fertilization may be due to the important role of nitrogen in the cell division process, increase its elongation and growth, which was reflected in raising the efficiency of roots in the absorption of nutrient elements (Morsi, 1977). This result agrees with (Kaushik and Gautam, 1980; Menezes *et al*., 1997; Saadi, 2000) who found an increase in plant lengths with increase the averages of nitrogen fertilizer.

Effect of the quality of irrigation water and nitrogen in some soil traits

Electrical conductivity (Ec)

The results of the statistical analysis showed that the quality of the irrigation water and the nitrogen had a significant effect on the degree of electrical conductivity of the saturated soil paste extract as shown in Table (6). While the interaction between them did not have a significant effect. Where the use of Suq Al-Shuyukh river water led to increase this trait with ratio of 3.89% compared to the irrigated with Al-Rifai river water. While the addition of the second and third levels of nitrogen fertilizer led to a decrease in this trait by giving it a ratio of (3.43%, 3.21%), respectively, compared to the first level.

The results of the increase in salinity of the soil are consistent with the increase salinity of irrigation water with the results of (Sardahi, 1985; Aboud, 1998; Al-Moussawi *et al*., 2002; Shukri, 2002) who obtained on the increase in soil salinity with increasing the salinity of irrigation water. This increase was due to the increase in added ions to the soil when irrigated with Suq Al-Shuyukh river water compared to the added ions when irrigated with Al-Rifai river water because it contains a higher concentration of ions than that of with Al-Rifai river water.

Table 6: Effect of the quality of irrigation water and nitrogen in the degree of electrical conductivity of the saturated soil paste extract ($ds.m^{-1}$)

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	3.89	3.80	3.43	3.21	3.58	**0.073**
S_2	2.59	2.50	2.30	2.07	2.37	
Average	**3.24**	**3.15**	**2.87**	**2.64**		
L.S.D 0.05 N	**0.091**					
L.S.D S x N	**NS**					

The decrease in the electrical conductivity of the saturated soil paste extract by increasing the levels of nitrogen fertilizer additive may be attributed to increased plant growth and absorption of a relatively large amount of dissolved ions in the soil, which led to a decrease. In addition, urea fertilizer is an organic compound (nonsaline), Al-Rihani (1978) found a decrease in the electrical conductivity of soil when using urea fertilizer compared to ammonium sulphate fertilizer.

Degree of Soil Interaction (pH)

The quality of irrigation water and nitrogen significantly affected the soil reaction, while the interaction between them did not have a significant effect, as shown by the results of the statistical analysis as shown in Table (7). The use of Suq Al-Shuyukh river water has led to reduce soil reaction from 7.86 to 7.61, while the second and third levels of nitrogen fertilizer have led to a decrease in soil reaction from 7.86 to 7.65 and 7.61, respectively.

Table 7: Effect of the quality of irrigation water and nitrogen in the degree of reaction of saturated soil paste extract

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	7.86	7.72	7.65	7.61	7.71	**0.066**
S_2	7.94	7.88	7.79	7.74	7.84	
Average	**7.9**	**7.8**	**7.72**	**7.68**		
L.S.D 0.05 N	**0.080**					
L.S.D S x N	**NS**					

The results of the decrease in the soil reaction when irrigation with saline water are consistent with the results of (Abboud, 1998; Shakri, 2002) obtained reduction in this trait by increasing the salinity of irrigation water, This decrease may be attributed to the accumulation of neutral salts which have affected the

degree of soil reaction towards the equalization, which has reduced them (Al-Zubaidi, 1989).The low soil reaction may be attributed to the increase in added nitrogen to the release of hydrogen ions due to the ammonium conversion to nitrate, Which has led to reduce the degree of soil reaction towards a neutral. Van Breeman *et al*. (1983); Berg, (1986); Schwab *et al*. (1989); Bowman and Halvorson (1998); Singh, (1999) found a decrease in the degree of soil reaction when using nitrogen fertilizers.

Sodium Adsorption Ratio (SAR)

The effect of irrigation water and nitrogen quality and their interaction have a significant effect on the Sodium Adsorption Ratio in the soil, as indicated by the results of the statistical analysis, as shown in Table (8). The use of Suq Al-Shuyukh river water in irrigation led to increase the Sodium Adsorption Ratio (3.09%) on the treatments irrigated with Al-Rifai river water. The addition of the second and third levels of nitrogen fertilizer led to increase the Sodium Adsorption Ratio (2.77%, 3.09%), respectively compared to the first level. While the interaction treatment between the third level of nitrogen fertilizer and Suq Al-Shuyukh river water (S1N3) achieved the highest increase of 3.09% compared with the interaction treatment between the first level of nitrogen fertilizer and Al-Rifai river water (S2.N1).

Table 8: Effect of the quality of irrigation water and nitrogen in the Sodium Adsorption Ratio in the soil

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	2.28	2.31	2.77	3.09	2.61	**0.107**
S_2	1.12	1.14	1.28	2.34	1.47	
Average	**1.7**	**1.73**	**2.03**	**2.72**		
L.S.D 0.05 N	**0.130**					
L.S.D S x N	**0.185**					

The increase in the Sodium Adsorption Ratio when irrigation with Suq Al-Shuyukh river water may be attributed to the increase in the concentration of sodium and increase the Sodium Adsorption Ratio in this water compared to the its percentage in Al-Rifai river water as shown in Table (8). This results agree with (Singh and Narain, 1980; Al-Sardahi, 1985; Al-Tai, 2000; Shukri, 2002) indicated that the Sodium Adsorption Ratio in the soil increased with increasing this percentage in irrigation water. The increase in the Sodium Adsorption Ratio in the soil may be attributed to the increase in the levels of nitrogen fertilizer added to the dominance of sodium ion on calcium and magnesium ions at these levels due to the decrease in sodium absorption by the barley crop with increasing the levels of nitrogen fertilizer. Al-Janabi (1980); Al-Tuplani (1985) have obtained on reduction of sodium absorption by plants when increasing the addition of nitrogen fertilizer.

Exchangeable Sodium Percentage (ESP)

Table (9) shows significant effects of the quality of irrigation water and nitrogen fertilizer and their interaction in the exchangeable sodium percentage, as shown in the results of the statistical analysis. When adding Suq Al-Shuyukh river water to the irrigated treatments by this water led to increase this percentage, with ratio of 2.57% on the treatments that irrigated with Al-Rifai river water. While this percentage increased with the addition of the second and third levels of nitrogen fertilizers (2.73%, 3.40%), respectively compared to the first level. The interaction treatment between the third level of nitrogen fertilizer and Suq Al-Shuyukh river water (S1N3) achieved an increase in this trait of 3.40% on the interaction treatment between the first level of nitrogen fertilizer and tAl-Rifai river water (S2.N1).

Table 9: Effect of the quality of irrigation water and nitrogen in the Exchangeable Sodium Percentage (ESP) in the soil

N / S	N0	N1	N_2	N_3	Average	L.S.D 0.05 S
S_1	2.02	2.11	2.73	3.40	2.57	**0.074**
S_2	0.49	0.53	0.68	1.66	0.84	
Average	**1.26**	**1.32**	**1.71**	**2.53**		
L.S.D 0.05 N	**0.090**					
L.S.D S x N	**0.127**					

The increase in the exchangeable sodium percentage when irrigated with Suq Al-Shuyukh river water may be attributed to an ion exchange between sodium and other positive ions. where sodium is likely to replace calcium and magnesium and thus increase its content in soil. This results agree with (Sardahi, 1985), which found an increase in the percentage of sodium exchange by increasing the salinity of irrigation water. The increase in the percentage of sodium exchange by increasing the addition of nitrogen may be due to the low absorption of sodium by the barley plant on the one hand, on the other hand, the increase in the proportion of sodium adsorbent accompanied by an increase in the percentage of sodium exchange as indicated by the results of (Allawi *et al*., 1981; Al-Nabulsi, 1997).

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