Indian Journal of Ecology (2023) 50(5): 1399-1402
DOI: https://doi.org/10.55362/IJE/2023/4069

Manuscript Number: 4069
NAAS Rating: 5.79

Effect of Irrigation Water Salinity Levels on Growth Indicators of Wheat (*Triticum aestivum* L.)

Abbas Jabbar Muhammad Al-Noor and Najla Jabber Muhammad Al-Amiri
Soil and Water Resources Sciences, College of Agriculture, University of Basra, Basra, Iraq
E-mail: abbasjm2000@gmail.com

Abstract: This experiment was conducted in the lathhouse of Basra during the 2021-2020 using plastic pots with a capacity of 5 kg. Three levels of salinity of irrigation water were 1, 3 and 5 dS.m^{-1}. The use of irrigation water with increasing levels of saline led to decrease in the average of production of dry weight of the vegetative part. When salinity levels rise (1 to 3 and 5dS.m^{-1}), there was decrease in calcium, magnesium and potassium in the plant vegetative part tissues and an increase in sodium and chloride content. The increase in the salinity of the irrigation water decreased the absorbed amount of calcium, magnesium, sodium and potassium and increased chloride absorbed.

Keywords: Salinity level, Irrigation water, Absorption, Element concentration, Wheat

Iraq's geographical location is within the dry and semi-arid areas and the dependence on irrigation in agriculture and the lack of rain and the control of neighboring countries over the headwaters of the Tigris, Euphrates and Shatt al-Arab rivers necessitates the use of saline water and poor quality water in agriculture to compensate for this shortage. Irrigation influence the yield and plays a major role in increasing the readiness to absorb nutrients, in the growth and division of cells and the regularity of the photosynthesis process (Ali and Ahmed 2017). The high concentrations of salts in the irrigation water have direct and indirect effects on the plant leading to reduction in the production of agricultural crops through the toxic effects of sodium ion, which leads to decrease in the effectiveness and activity of cells and their ability to divide (Al Faki 2010). The indirect effects which results in an environment that is not suitable for plant growth and thus affects productivity (Fahad et al 2015). The wheat crop is one of the most important strategic crops in Iraq, as it ranks first in terms of its cultivated area and 4,343.473 million tons annually (Iraqi Ministry of Agriculture 2020), compared to other countries such as Egypt, which produces an average of 8.8 million tons annually (FAO 2018). Therefore, many studies conducted to study the effect of different levels of salinity of irrigation water on the growth and production of wheat. Hussein et al (2011) observed that by increasing the electrical conductivity of irrigation water (4.6 and 9.3 dS.m^{-1}), the absorption of nitrogen, phosphorous, potassium, calcium and magnesium decreased, while the absorption of sodium and chloride ions increased in the vegetative growth of wheat with an increase in the salinity of irrigation water. Al Delfi (2013) showed that with an increase in the electrical conductivity (EC) of irrigation water (1.50 and 8 dS.m^{-1}) there was an increase in the concentration of magnesium, sodium and chloride, and a decrease in the concentration of potassium, calcium and the percentage of potassium to sodium in the vegetative part of the corn plant. Abboud and Abbas (2013) found that increasing the levels of electrical conductivity (EC) in irrigation water (2, 4 and 8 dSm^{-1}) used for irrigation of wheat and led to an increase in the absorption of sodium, calcium and magnesium, and a decrease in potassium absorption, as well as the ratio of potassium to sodium (K\Na). Al Kaabi (2017) indicated that the increase in the electrical conductivity (EC) of irrigation water (3 and 6 dS.m^{-1}) led to a non-significant decrease in the dry weight of the vegetative total of wheat plan. The present study was carried out to obeserve effect of water salinity on the growth of the wheat crop.

MATERIAL AND METHODS

The experiment was conducted in the lath house College of Agriculture, the University of Basra during 2020 using 5 kg plastic pots in completely randomized design with three replications. The physical and chemical properties of the soil used in the experiment were estimated and are presented in table 1. The soil was fertilized with nitrogen @ 200 kg N ha^{-1} in the form of urea fertilizer 46% nitrogen. Nitrogen was added in two batches, day before the date of sowing wheat mixed with the soil and the second after a month from sowing dissolved with irrigation water. Phosphorus was added @ 100 kg P ha^{-1} in the form of concentrated superphosphate fertilizer, 20.21% phosphorous, day before sowing, mixed with the soil, Potassium was added at 120 kg ha^{-1} in the form of potassium sulfate fertilizer 40.43% potassium at once before sowing, mixed with the soil (Jadoa 1995). Irrigation water was done according to the electrical conductivity in the experiment after preparing a brine solution of known concentration of (MgSO4) salt and diluted to the required salt levels of 1, 3 and 5 dS.m^{-1} by mixing it with distilled water using the following equation (Ayers and Westcot 1985)

$$EC1 = [ECa * a] + [ECb(1-a)]$$

EC1 = Electrical conductivity of the water to be obtained (dS.m^{-1}).

ECa = Electrical conductivity of water used for dilution (dS.m^{-1}).

ECb = Electrical conductivity of drainage water (dS.m^{-1}).

EC1 = Electrical conductivity of water to be obtained (dS.m^{-1}).

a = percentage of water used for dilution (dS.m^{-1}).

The required electrical conductivity values were ascertained by measuring their electrical conductivity after dilution.

Wheat variety Buhooth 22 was sown on November 11, 2020 with 15 seeds per pot and then irrigated with tap water and arranged randomly, covered with black nylon to encourage germination. After germination, thinning was done to keep 10 plants per pot and after ten days were irrigated with the prepared irrigation water levels, in addition, to tap water as a control treatment and equivalent to the field capacity while maintaining moisture in the periodic weight of the pots and completing the deficiency with the same water for each treatment. The experiment continued for 60 days. After 60 days of planting, vegetative part of the plant at were harvested 1.5 cm from above soil surface to avoid contamination. The dry weight of the vegetative growth was calculated by drying the plant samples in an oven at 65-70°C until the weight was stable. The dried plant samples were grounded with an electric grinder, then a certain weight of the plant tissue was taken and digested using an acidic mixture (concentrated sulfuric acid H2SO4 + perchloric HClO4 4%) by heating until a clear solution was obtained according to Purson Cresser method. Sodium and potassium were estimated in the digestion solution using flame photometer rand calcium and magnesium using Phoenix-986 atomic absorption spectrophotometer. The chloride was estimated by taking 0.2 gm of the prepared sample and extracted by (2%) acetic acid, and it was determined by blotting method with 0.01N silver nitrate using 5% potassium chromate index after adjusting the acidity of the extract (Kalra 1998). The absorbable amount of the elements (calcium, magnesium, sodium, potassium and chloride) in the samples was calculated by multiplying the concentration of the element in the plant tissues with the weight of the dry matter of the plant.

RESULTS AND DISCUSSION

Dry matter production (g): The average dry weight of the vegetative part of the wheat plant in response to different salinity levels is depicted in Figure 1. The increase in irrigation water salinity levels from 1 to 3 and 5 dS.m^{-1} led to a significant decrease in the dry matter production of wheat. T1 level was significantly superior to T5 level with dry weight of 14.76 g but it was not significantly superior to the T3 level. This decrease in the dry weight of the vegetative part of wheat with the increase in the salinity can be due to negative effect on the vital processes such as photosynthesis, protein synthesis, and the reduction of total soluble sugars, affecting vital activities and consequently decrease the dry weight of the plant (Bernstein 2011). The increase in salinity levels in the irrigation water has harmful effects on the growth of crop plants due to its osmotic and watery effect of the plant and consequently decrease the growth. Khan (2013) observed that the increase in the salinity of irrigation water leads to high osmotic pressure in the soil solution as a result of the accumulation of salts in the root zone, and consequently, the lack of water availability for the plant as a result of low water

Table 1. Chemical and physical properties of soil before planting

Traits		Values	Units
pH (1:1)		7.30	——
Electrical conductivity (EC)		3.45	dS.m^{-1}
Organic matter		11.4	g.kg^{-1}
Dissolved ions	Ca^{2+}	6.6	mmol.L^{-1}
	Mg^{2+}	4.0	
	Na^{+}	16.1	
	K^{+}	2.2	
	Cl^{-}	22.3	
	$SO_4^{=}$	7.1	
	CO_3^{-}	0.0	
	HCO_3^{-}	2.1	
	SAR	4.94	
Soil separators	Clay	390.0	g.kg^{-1}
	silt	317.3	
	sand	292.7	
Soil texture		Clay Loam	——

Table 2. Effect of irrigation water salinity levels on the concentration of ions in wheat (%)

Salinity levels (dS m^{-1})	Ion concentration (%) in wheat				
	Cl	K	Na	Mg	Ca
T1: 1	0.70	1.27	1.80	0.60	1.53
T3: 3	1.01	1.25	1.88	0.55	1.40
T5: 5	1.21	1.01	1.94	0.50	1.06
Control	0.53	1.28	1.05	0.35	1.40
CD (p=0.05)	0.61*	0.36ns	0.23**	0.35ns	0.23**

potential. This causes physiological thirst of the plant despite the availability of water in the soil. These results agree with the findings of earlier workers (Rajpar et al 2011, Yassin et al 2011, Al Shammari 2012 and Eissa et al 2018).

Effect of irrigation water salinity levels on the concentration of ions: The increase in the salinity levels of irrigation water reduce calcium content. There were highly significant differences in T1 and T3 compared to the salinity level T5. Ali (2012) observed that the nutritional balance within the plant is directly related to the presence of Ions of some elements of the salts in the soil solution. Al-Shammari (2012) concluded that the increased salinity led to a reduction in calcium, magnesium, and potassium, and an increase in sodium in vegetative parts of wheat plant.

There were non-significant differences for the increase in salinity levels in the concentration of magnesium in plant and it decreased from 0.60 to 0.55 and 0.50% for levels T1, T3 and T5, respectively, compared to control treatment (0.35%). The highest concentration of sodium was at T5 (1.94%), while the levels T3 and T1 recorded an average concentration of 1.88 and 1.80%, respectively. The potassium concentration in the vegetative part of the wheat indicated that there were no significant differences due to imposed salinity levels through irrigation water. The potassium concentration decreased from 1.27 to 1.25 and 1.01% with an increase in the salinity levels of irrigation water from T1 to T3 and T5, respectively. Al Delfi (2013) explained the decrease in potassium concentration in plant tissues with increasing salinity of irrigation water decrease the growth due to obstruction in absorption of ions by the plant, including potassium. The results indicated that the chloride concentration in the vegetative part of the wheat plant increased with an increase in the salinity levels however were no significant differences. The results agree with the findings of Al Shammari (2012), Shamsi and Kobaraee (2013) and Al Kaabi (2017).

Ions absorbed in the wheat plant (g): The highest amount of Ca absorption was in the control treatment (243.18 g) followed by T1, T3 and T5 with a decrease in the amount of calcium absorbed by 7.13, 20.78 and 51.62% compared to the control treatment (Table 3). Ragab et al (2008) observed that low absorption of nutrients by plants is that plants exposed to salinity spend most of their energy in osmotic regulation of water withdrawal from the external environment, which causes an imbalance in the absorption of nutrients.

There were no significant differences for the increase in the levels of salinity of irrigation water in the absorbed amount of magnesium. The lowest absorbed amount was recorded by the saline level of 5 $dS.m^{-1}$, while the control treatment achieved 60.79 g of the absorbed amount of magnesium in wheat plant. Al Zubaidi (2011) indicated that each element has a specific function in the vital processes that take place in different plants, and when an element is greatly increased or decreased, this causes an imbalance in one of the bio processes. Sodium absorbed in the vegetative part of the wheat plant was significant in at salinity levels T1 and T3 compared with the control treatment. Sodium decreased with the increase in the salinity levels of the irrigation water, with a decrease of 2.63, 18.95 and 31.35% for the levels T3 and T5 and the control treatment, respectively, compared to the T1 level. The lowest absorbed amount of sodium was in control treatment (182.38 g), while the highest amount was absorbed at the T1 level (265.68 g). This may be because the salinity of the irrigation water causes an imbalance in the nutritional balance in the soil and plants, as well as the effect of salinity on the phenomenon of preference for plants to absorb the required nutrients (Al Zubaidi 2011). The concentration of salts in the soil causes competition between the salt ions and the ions needed by the plant, as the plant absorbs ions with high salt concentrations than required for metabolic processes (Verbruggen and Hermans 2013). There were no significant differences in the absorbed amount of chloride, but the increase in the levels caused an increase in the absorbed amount of chloride, reaching 103.32, 138.97 and 134.31% for levels T1, T3 and T5,

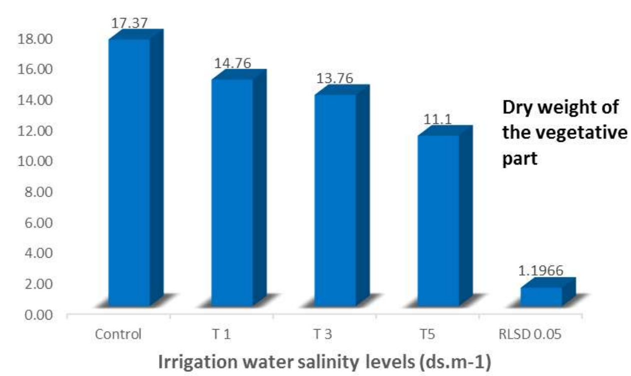

Fig. 1. Effect of irrigation water salinity levels on the dry weight of wheat (g)

Table 3. Effect of irrigation water salinity levels on the amount absorbed by wheat (g)

Salinity levels ($dS\ m^{-1}$)	Absorbed amount (mg) in wheat				
	Cl	K	Na	Mg	Ca
T1:1	103.32	187.45	265.68	88.56	225.83
T3:3	138.97	172.00	258.69	75.68	192.64
T5:5	134.31	112.11	215.34	55.50	117.66
Control	90.06	222.34	182.38	60.79	243.18
RLSD	51.66ns	60.53**	52.99**	33.50ns	33.72**

respectively. In control treatment, the lowest amount of chloride ion was absorbed (90.06 g). In general, these results agree with the findings of Al Ghurairi (2011) and Hussein et al (2011) that increasing the salinity of water irrigation led to decreased absorption of calcium, magnesium and potassium. Abboud and Abbas (2013) however, observed that the increase in the salinity of irrigation water led to an increase in the absorption of sodium, calcium and magnesium and a decrease in the absorption of potassium.

CONCLUSION

This study indicated that increased and frequent saline water irrigation resulted in gradual salt accumulation in the soil, which negatively affected growth of wheat plant as a result of low absorption of the ions needed by the plant.

REFERENCES

Ali HK and Ahmed HT 2017. The components and yield of the bread wheat grains were affected by the potassium spray time and the salinity of the irrigation water. Diyala *Journal of Agricultural Sciences* **9**(2): 135-145.

Abboud MR and Abbas AK 2013. The use of some treatments in relieving salt stress in the growth and production of wheat, Sham variety. *Al-Furat Journal of Agricultural Sciences* **3**(5):245-259.

Al Delfi HF 2013. *The role of organic waste in reducing the effect of irrigation water salinity on soil properties and the growth of maize plant (Zea mays L.).* M.Sc. thesis, University of Basra, Iraq.

Al Ghurairi SM 2011. *Reducing the harmful effect of salt stress on the growth and yield of wheat by using foliar fertilization*. Ph.D. thesis, College of Agriculture, University of Baghdad. Iraq.

Al- Jafar SK 2014. *Response of bread wheat cultivars to irrigation water quality, potassium fertilization and genetic correlation coefficient estimation*. M.Sc. thesis, College of Life Sciences for Girls, University of Karbala. Iraq.

Al Kaabi HH 2017. *Effect of salinity of irrigation water, salicylic acid spray and potassium fertilization on salt tolerance of wheat plants*. M.Sc. thesis, University of Basra, Iraq.

Al Fiqi AH 2010. *Effect of salinity on plants (soil salinity).* Department of Botanical Gardens, Horticultural Research Institute. Power Point Presentation Lecture. http://happytreeflash.com/-ppt.html

Ali HF 2012. Response of tomato plant to spraying with cyclocyl and nutrient NPK grown in desert soil. *Kufa Journal of Agricultural Sciences* **2**(4): 137-156.

Al Shammari AM 2012. *The interaction between salinity, hormones and vegetation and its effect on the growth and detection of wheat plants*. M.Sc. thesis, College of Education for Pure Sciences, University of Diyala, Iraq.

Received 30 March, 2023; Accepted 30 August, 2023

Al Zubaidi MW 2011. *Effect of magnetization of seeds and fresh and saline irrigation water on germination, growth and yield of maize* (*Zea mays* L.). M.Sc. thesis, College of Education, University of Diyala, Iraq.

Ayers RS and Westcot DW 1985. *Water for agriculture irrigation and drainage*. paper (29 Rev. 1) FAO, Rome, Italy.

Bernstein J 2011. Root growth of tomato is more sensitive to salinity than shoot growth. *Journal of Environmental Sciences* **64**(12): 1676.

Eissa MA, Rekaby SA, Hegab SA and Ragheb HM 2018. Effect of deficit irrigation on drip irrigated wheat grown in semi-arid conditions of Upper Egypt. *Journal of Plant Nutrition* **41**(12): 86-1576.

Fahad AA, Hassan KM, Faleh AS and Rasheed TL 2015. Magnetic conditioning of salt water properties for crop irrigation Sunflower. *Iraqi Journal of Agricultural Sciences* **36**(1): 23-28.

FAO 2018. *Food and Agriculture Organization of the United Nations Rome*. FAOSTAT, Crops.

Gresser MS and Parsons JW 1979. Sulphuric-perchloric determination of nitrogen, phosphorous, potassium calcium and magnesium. *Analytica Chimica Acta* **109:** 431-436.

Hussein SS, Kayani MA and Amjad M 2011. Transcription factors as tools to engineer enhanced drought tolerance in plants Biotechnol. Prog. **27:** 297-306.

Kalra YP 1998. *Hand book of methods for plant analysis*. Soil and plant analysis council, Inc. extractable chloride, nitrate, orthophosphate, potassium, ad sulfate I, plant tissue: 2% acetic acid extraction. Robert O. Miller: Copyright 1998 by Taylor and Francis Group, LLC. P 115-118.

Khan A 2013. Coordinate changes in Assimilatory sulfate reduction are correlated to salt tolerance involvement of phytohormones, sciencedomain. *Org*. **3**(3): 267-295.

Ministry of Agriculture 2020. *Department of Planning and Follow-up*. Department of Agricultural Statistics in the Ministry of Agriculture. Republic of Iraq.

Ragab AA, Hellal FA and Abd El Hady M 2008. Water salinity impacts on some soil properties and nutrients uptake by wheat plants in sandy and calcareous soil. *Australian Journal of Basic and Applied Sciences* **2**(2): 225-233.

Rajpar L, Jandan L, Ul Hassan Z, Jamro GM and Shah AN 2011. Enhanced fodder yield of maize genotypes under saline irrigation is a function of tgeir increased K accumulation and better K/Na ratio. *African Journal of Biotechnology* **10:** 1559 -1565.

Shamsi k and Kobraee S 2013. Biochemical and physiological responses of three wheat cultivars (*Triticum aestivum* L.) to salinity stress. *Annals of Biological Research* **4**(4):180-185.

Verbruggen N and Hermans C 2013. Physiological and molecular responses to magnesium nutritional imbalance in plants. *Plant Soil* **368:** 87-99.

Yassin MF, Al Bayati AH and Musleh AF 2011. Effect of irrigation water quality on availability, potassium absorption, growth and yield of wheat in some expansion areas in western Iraq. *Tikrit University Journal of Agricultural Sciences* **11**(4): 151-163.