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RESEARCH PAPER

Influence of seed pretreated in sodium chloride on the salt tolerance of cherry radish (*Raphanus sativus* L.).

Idress A. Al Gehani[1*] Sami A. Alasheebi[1] Taher M. Mohammed[1] and Abdulhakim S. Banni[2]

استجابة المعاملة المسبقة بنقع بذور الفجل الكرزي (*Raphanus sativus* L.) في محلول كلوريد الصوديوم على تحمل نمو النبات تحت ظروف الإجهاد الملحي

إدريس أحمد الجهاني ١ *، سامي علي العشيبي ١، طاهر محمد محمد ١، عبد الحكيم سعد بني ٢

Abstract. This study was conducted to evaluate the effect of sodium chloride (NaCl) seed soaking on seed germination and plant growth of cherry radish (*Raphanus sativus* L.) under saline conditions. Seeds were pretreated by soaking in NaCl solutions at concentrations of 0, 1500, 3000 and 4500 ppm. The pretreated seeds were divided into two groups: the first group was germinated in Petri dishes, and the second group was sown in pots. Both groups were irrigated with different concentrations of salinity (tap water, 1000, 2000 and 3000 ppm NaCl). The results indicated that the salinity of the irrigation water decreased the seed germination percentage and leaf chlorophyll content under a salinity level of 3000 ppm. On the other hand, pretreatment of seeds with NaCl solution led to a gradual increase in germination percentage and total chlorophyll content of leaves. Pretreatment with 4500 ppm NaCl gave comparable values to the effect of control treatment under irrigation conditions with 1000 and 2000 ppm salinity. However, pretreatment of seeds with NaCl led to a gradual decrease in germination percentage, reaching 60% under a salinity level of 3000 ppm, and no obvious effect was seen on the leaf chlorophyll contents. Pretreatment of seeds by NaCl solutions increased the root and shoot fresh and dry weights, while shoot and root weight gradually decreased with the increasing salinity of irrigation water and regardless of the effects attributed to seed pretreatment. The increase in irrigation water salinity also led to a decrease in leaf area, and root length and root diameter, as well as root water contents. In contrast, the salinity led to a gradual increase in leaf specific weight, while the value of leaf number and leaf water contents were not affected. Therefore, the increased specific leaf weight as a result of the salinity of the irrigation water gave an indication that soaking the seeds in saline solutions increased the plant tolerance to salinity that lead to better plant growth.

Keywords: Soaking seeds, Salinity, Salt tolerance, Radish

الملخص: بذور فجل كرزي (*Raphanus sativus* L.) استنبتت في أطباق بتري في حين زرعت مجموعة أخرى في أصص لدراسة تأثير المعاملة المسبقة بنقع البذور في محاليل كلوريد الصوديوم (NaCl) بتركيزات 0، 1500، 3000 و 4500 جزء في المليون على إنبات ونمو النبات تحت ظروف الملوحة بالري بتركيزات مختلفة من الملوحة (ماء الصنبور،1000، 2000 و 3000 جزء في المليون). أشارت النتائج إلى أن الزيادة في ملوحة مياه الري أدت إلى انخفاض نسبة إنبات البذور (GP) وإجمالي محتوى الأوراق من الكلوروفيل تحت مستوى ملوحة بلغ 3000 جزء في المليون. حيث أدت المعاملة المسبقة للبذور بمحلول NaCl إلى زيادة تدريجية في GP ومحتوى الكلوروفيل الكلي للأوراق. من الواضح أن المعالجة المسبقة بـ 4500 جزء في المليون من NaCl أعطت قيماً مماثلة لتأثير معاملة المقارنة تحت ظروف الري مع ملوحة 1000 و 2000 جزء في المليون. من ناحية أخرى، أدت المعالجة المسبقة للبذور NaCl إلى انخفاض تدريجي فيGP وصل إلى 60% تحت ظروف الري بمستوى ملوحة 3000 جزء في المليون، ولم يلاحظ أي تأثير واضح على محتوى الكلوروفيل. أدت المعالجة المسبقة للبذور عن طريق النقع في محاليل NaCl إلى زيادة الوزن الطازج (FW)والوزن الجاف (DW) لكل من المجموع الخضري والجذري. بينما انخفض وزن المجموع الخضري والجذري تدريجياً مع زيادة ملوحة مياه الري وبغض النظر عن التأثيرات المنسوبة إلى المعاملة المسبقة للبذور. أدت الزيادة في ملوحة مياه الري أيضًا إلى انخفاض مساحة الورقة (LA)، وطول (LR) وقطر (DR) الجذور، ومحتوى الماء (WC) للجذور. في المقابل، أدت الملوحة إلى زيادة تدريجية في الوزن النوعي للأوراق (SLW)، بينما لم تتأثر قيمة عدد الأوراق (LN)ومحتواها المائي (WC). لذلك، فإن زيادة SLW نتيجة لملوحة مياه الري، مما يعطي مؤشرا على أن نقع البذور في المحاليل الملحية يزيد من قدرة تحمل النبات لظروف الإجهاد الملحي، مما يؤدي إلى نمو وتطور أفضل للنبات.

الكلمات المفتاحية: نقع البذور، ملوحة، تحمل الملوحة، فجل.

Introduction

Salinity in soil or water is one of the major abiotic stresses that are widespread in the world (Ibrahim, 2016), as about 20% of the world's cultivated land and half of the irrigated land are affected by salinity (Kasim et al., 2016). Thus, it is considered a main factor reducing crop productivity in arid and semi-arid areas (Cayuela et al., 2001). Salinity may occur as a result of over-irrigation, irregular drainage, and imbalanced application of fertilizers (Ayyub et al., 2016). Salt stress affects all major plant processes such as growth, photosynthesis, protein synthesis, and metabolism of amino acids and organic acids (Kasim et al., 2016) through the osmotic effect induced by water deficit. The salinity of the soil solution reduces the ability of plants to absorb water or is influenced by the specific effect of excessive amounts of absorbed salts, especially Na+ and Cl-. In addition to their toxic effects on plants, they reduce the absorption of nutrients, as well as ionic imbalance (Mo-

Idress A. Al Gehani[1*] (✉) idress.algehani@uob.edu.ly, [1]Department of Plant Production, Faculty of Agriculture, University of Benghazi, Benghazi, Libya, [2]Department of Botany, Faculty of Arts and Sciences (Almarj), University of Benghazi, Libya.

hamed and Gomaa, 2012). Salinity decreases the CO_2 assimilation rate, and the excess of light absorbed that is not used by the plant can lead to an increase in reactive oxygen species production and, consequently, oxidative stress (Ma et al., 2020). These stressful conditions cause a change in the hormonal balance of plants, such as a decrease in auxins and gibberellins and an increase in abscisic acid in plant tissues (Ibrahim, 2016).

The radish plant is a root vegetable, and it belongs to the cruciferous family. Its roots are consumed fresh and sometimes in pickling, and it has several therapeutic benefits. Due to the importance of this crop and the consumer demand for it, this led to an increase in the spread of its cultivation, but it faced the problem of salinity, which led to a decrease in production.

The researchers indicated that salinity reduced the percentage and rate of germination of radish seeds (Jamil et al., 2007; Kaymak et al., 2009). Several studies have shown that salinity reduces plant height, leaf area, and the fresh and dry weight of the shoot and root of the radish plant (Mohamed and Gomaa, 2012; Chaparzadeh and Hosseinzad-Behboud, 2015; Jasim et al., 2016). It was also found by de Sousa Basílio et al. (2018) that salinity reduced the number of leaves and the diameter of the root of radish plants. In addition, salinity has decreased the root length, shoot length, and fresh weight of the shoot and root parts (Jamil et al., 2007). Salinity reduced the percentage of chlorophyll (Yildirim et al., 2008; Chaparzadeh and Hosseinzad-Behboud, 2015; Jasim et al., 2016) and relative water content of radish plant leaves (Yildirim et al., 2008). Whereas Jamil et al. (2007) discovered that salinity decreased the content of chlorophyll in leaves while having no effect on the water content of radish leaves. On the other hand, Mohamed and Gomaa (2012) indicated that the content of chlorophyll a, b, and total as well as the content of IAA and GA3 have decreased. In contrast, the content of abscisic acid has increased.

Based on the increased risks of salinity and the need for better salinity-tolerant crops (Esmaielpour et al., 2006), and to reduce the effect of salinity on the growth and production of crops, many treatments are carried out on plants, such as seed soaking with antioxidants, growth regulators, and salts (Gebreegziabher and Qufa, 2017). Soaking the seeds is one of the beneficial physiological methods by which plants can adapt to saline conditions, and it is an easy, low-cost, and safe technique that is used to overcome the salinity problem in agricultural lands (Ibrahim, 2016). Seed soaking or pretreating with NaCl is considered a successful method because it not only reduces the effect of salt stress during germination but also increases the salinity tolerance during the plant growth stage (Sivriepe et al., 2005). For instance, treating maize seeds in NaCl solution increased the percentage and speed of germination, plant height, length of branches, and yield under salt stress conditions (Gebreegziabher and Qufa, 2017). Esmaielpour et al. (2006) also reported that pretreating cucumber seeds with NaCl increased the percentage and rate of germination, dry weight, and length of roots under saline stress conditions. On the other hand, it decreased the percentage of Na^+ and increased the content of K^+, Ca^{+2}, and proline in plants. Bajehbag (2010) found that treating sunflower seeds with NaCl increased the percentage of germination and reduced the time required for germination. It also increased root length, plant height, plant dry weight, and the number of leaves. In another study, Sivritepe et al. (2005) reported that treating watermelon seeds with NaCl increased the dry matter of leaves, leaf area, number of leaves, and plant height as well as chlorophyll content. In tomato, seed treatment with NaCl increased plant biomass, fresh and dry weight of shoots and root dry weight, decreased Na^+ and Cl^-content, and increased K^+ in the plant (Cayuela et al. 2001). Seed pretreatment has proved to be an effective technique to improve the germination performance, seedling growth, and seed yield of maize (Tian et al., 2014). Cao et al. (2018) indicated that seeds soaked with NaCl could remarkably enhance antioxidant metabolism, thereby decreasing the accumulation of reactive oxygen species and membrane lipid peroxidation during germination under water stress.

Therefore, due to the dependence of the Benghazi plain region in Libya on groundwater for irrigating crops, and this source having a relatively high salt content, that would negatively affect agricultural production in this region. Based on the previously mentioned benefits of pretreatment of seeds before sowing and its positive effect in facing the problems of high salinity levels, this study aims to know the effect of soaking seeds in solutions of sodium chloride salt on the growth and development of the radish plant under salt stress conditions.

Materials and Methods

Plant Material, Growth Conditions and Treatments

The experiment was carried out by planting the cherry radish variety (*Raphanus sativus* L.) at the research station of the Faculty of Agriculture-University of Benghazi, Libya during the winter seasons of 2018 and 2019. The seeds were pretreated by soaking in solutions of different concentrations of sodium chloride (NaCl) at 0, 1500, 3000, and 4500 ppm at room temperature for 24 h. One group of pretreated seeds (20 seeds) were placed in each Petri dish to calculate their germination percentage at 19°C (Wilcox and Pfeiffer, 1990). Another group of pretreated seeds (4 seeds) was sown in a silty clay soil mixed with sand and compost (1:1:1 vol.) in a 3-L pot (20×20 cm diameter × height), two seedlings were maintained in each pot. Soil composition was 1.27% organic matter, 20% calcium carbonate, pH 7.56, EC 0.98 dSm^{-1}, available P 10.4 ppm and total N 0.11%. Throughout the experiment, the plants were fertilized by modified Hoagland Solution as a complete nutrient solution with irrigation.

The full nutrient solution contains (mmol L^{-1}) 5 KNO_3, 5 $Ca(NO_3)_2 \cdot 4H^2O$, 2 $MgSO_4 \cdot 7H_2O$, 1 KH_2PO_4, mixture of 0.02 $FeSO_4 \cdot 7\ H_2O$; 0.02 Na_{2-} EDTA; 2 H_2O; 0.045 H_3BO_3; 0.01 $MnCl_2$.4 H_2O, and (in μmol/L) 0.8 $ZnSO_4 \cdot 7\ H_2O$, 0.4 $Na_2MoO_4 \cdot 2\ H_2O$, and 0.3 $CuSO_4 \cdot 5\ H_2O$. Seedlings were grown under a plastic canopy for protection from rain at 10 h photoperiod, photosynthetic active radiation reached a daytime peak value of 800 μmol m^{-2} s^{-1}, the temperature and relative humidity were 17/9 °C and 70/89% during day/night periods, respectively.

Treatments began with the sowing of pretreated seeds, followed by irrigation with various concentrations of salty water. The irrigation was carried out daily with 4 levels of salt water: tap water (the concentration of salts is about 500 ppm), 1000, 2000, and 3000 ppm, prepared by adding 0, 500, 1500, and 2500 ppm of NaCl to tap water, respectively. The amount of irrigation was added according to the needs of the plant and the change in the daily temperature. With respect to the increase in the size of the plant in terms of the gradual increase in the amount of irrigation water needed by the plant to reach the field capacity at each irrigation. Treatments continued till 45 days until achieving the economic stage of cherry radish roots.

Germination and Vegetative Stage Measurements

The germination percentage (GP) was calculated as (the number of seeds germinated/the total seeds×100). Ten seedlings for each treatment were used to measure and count the fresh weight (FW) of shoots and roots, the leaf number and leaf area (LN and LA), as well as the length and diameter of roots (RL and RD) at the end of the experiments. The plants were dried for 72 hours in an oven at 65 °C (until there was no decrease in weight) for the determination of dry weight (DW) and percentage of water content (WC) of shoots and roots. According to Morgan (1984), the WC was calculated as WC={(FW-DW)/FW}*100

The specific leaf weight (SLW) was determined by dividing values of leaf dry weight by leaf area (Lei Zhang et al., 2012). The total chlorophyll content of the leaves was calculated on a fresh weight according to Moran (1982). A fully developed leaf was selected from the middle section of shoots on each plant. Ten leaf discs were punched and immersed in 10 ml of N,N-dimethylformamide (Moran and Porath, 1980). The samples were stored in darkness at 4°C for 24 h. The absorbance of the pigment extract was determined photometrically at 603 nm, 647 nm, and 664 nm.

Experimental Design and Statistical Analysis

The data represents the mean values of two independent experiments for each season. The experiments were conducted using 5 replicates for each treatment (each

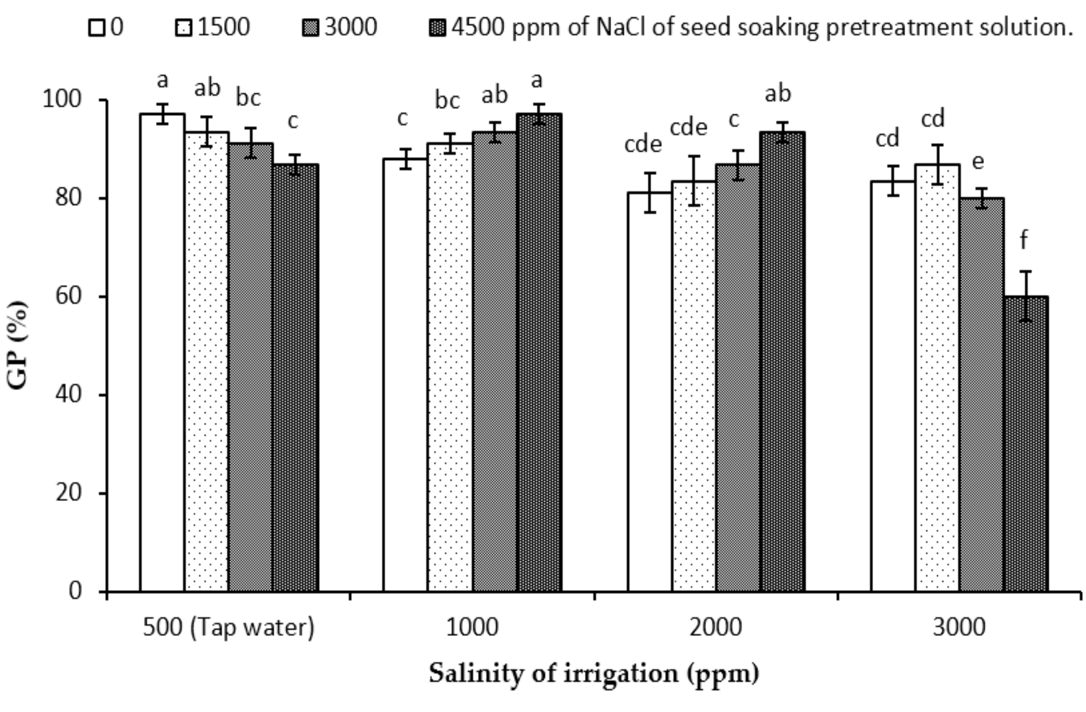

Figure 1. Effect of seed soaking pretreatment in NaCl solution and salinity of irrigation on germination percentage (GP) of radish seeds.

Bars represent standard errors. Different letters indicate a significant difference between treatments by Duncan's multiple range test at 5% level.

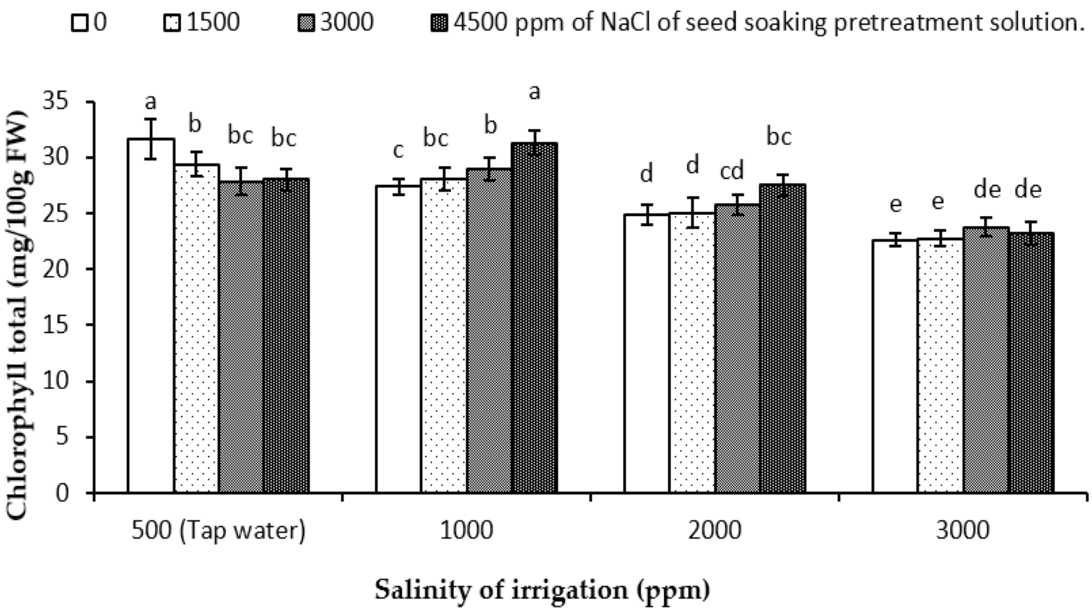

Figure 2. Effect of seed soaking pretreatment in NaCl solution and salinity of irrigation on chlorophyll content of radish leaves.
Bars represent standard errors. Different letters indicate a significant difference between treatments by Duncan's multiple range test at 5% level.

replicate consisted of 20 seeds in one Petri dish for germination stage measurement and two plants in each pot for vegetative stage measurements). A factorial experimental 4×4 in a completely randomized design was used with the treatments of soaking seeds pretreatment and salinity of irrigation treatment. Data were subjected to analysis of variance using a two-way ANOVA test and means were compared by Duncan's means test ($P<0.05$) using the SAS GLM procedure (SAS Institute, Cary, NC).

Result

The results indicated that increasing the salinity of the irrigation water led to a gradual decrease in the germination percentage (GP) of radish seeds from 97% with the control treatment to 81% with the 3000 ppm treatment (Figure 1). The total chlorophyll decreased from 31.6 to 22.6 (mg/100g FW) with 3000 ppm treatment (Figure 2.). Whereas the pretreatment of the seeds with NaCl solutions led to a gradual increase in the GP and the content of leaves from total chlorophyll, which was accompanied by an increase in the concentration of the used solution. Obviously, the pretreatment with 4500 ppm of NaCl results in comparable value to the effect of the control treatment under the condition of irrigation with 1000 and 2000 ppm of salinity (Figures 1 and 2). On the other hand, the pretreatment of the seeds with NaCl led to a gradual decrease in the GP, reaching 60% under the condition of irrigation at a salinity level of 3000 ppm (Figure 1), and no clear effect was shown on the amount of chlorophyll (Figure 2).

Pretreatment of the seeds by soaking in NaCl solutions increased the fresh weight (FW) and dry weight (DW) of both shoots and roots. The shoot was from 16.9 and 1.3 to 23.4 and 1.9 g, respectively, and the root was from 7.46 and 0.6 to 12.8 and 0.9 g, respectively (Tables 1 and 2). While the shoot and root weight were gradually decreased with increasing the salinity of the irrigation water, regardless of the effects attributed to the pretreatment of the seeds. The increase in the salinity of the irrigation water also led to a decrease in the leaf area (LA) (Table 1), the length (LR), diameter (DR) and water content (WC) of the roots (Table 2), and in contrast to a gradual increase in the specific weight of the leaf (SLW), while the value of the number of leaves (LN) and their water content (WC) were not affected (Table 1).

Discussion

Salt stress caused significant decrease in the germination and growth of radish. The decrease was attributed to the increased salts in the irrigation water led to a rise in the osmotic pressure of the soil solution, which led to an increased in the viscosity of the soil solution (Kaymak et al., 2009; Bajehbaj, 2010). On the other hand, the

Table 1. Effect of seed soaking pretreatment in NaCl solution and salinity of irrigation on fresh weight (FW), dry weight (DW), leaf number (LN), leaf area (LA), specific leaf weight (SLW) and water content (WC) of radish shoots

Treatments		Measurements					
Conc. of seed socking solution (NaCl ppm)	Salinity of Irrigation (ppm)	FW (g/shoot)	DW (g/shoot)	LN (leaf)	LA (cm^2)	SLW (g/cm^2)	WC (%)
0	500	16.98^{b-f}	1.36^{a-e}	6.20^{e}	131.93^{ab}	0.144^{h}	91.82^{b-f}
	1000	11.24^{g-h}	0.80^{de}	6.20^{e}	69.20^{de}	0.165^{d-h}	92.56^{a-d}
	2000	9.94^{h}	0.70^{e}	6.25^{e}	47.79^{e}	0.177^{d-g}	92.48^{a-d}
	3000	9.56^{h}	0.86^{c-e}	6.20^{e}	43.61^{e}	0.186^{c-f}	91.01^{e-g}
1500	500	23.46^{a}	1.96^{a}	8.00^{a}	136.85^{ab}	0.145^{h}	91.95^{b-f}
	1000	19.22^{bc}	1.38^{a-e}	7.60^{ab}	123.25^{a-c}	0.156^{gh}	92.77^{a-c}
	2000	16.82^{b-f}	1.58^{a-c}	6.60^{de}	107.27^{b-d}	0.158^{f-h}	90.90^{fg}
	3000	13.26^{e-h}	1.24^{a-e}	6.75^{de}	67.22^{de}	0.212^{bc}	91.10^{e-g}
3000	500	20.30^{ab}	1.34^{a-e}	6.27^{e}	135.07^{ab}	0.170^{d-h}	93.38^{a}
	1000	17.20^{b-e}	1.22^{b-e}	6.80^{c-e}	127.00^{a-c}	0.175^{d-g}	92.95^{ab}
	2000	15.24^{c-g}	1.47^{a-d}	7.40^{a-c}	136.20^{ab}	0.188^{c-e}	90.48^{g}
	3000	13.72^{d-h}	1.36^{a-e}	6.80^{c-e}	62.50^{de}	0.230^{ab}	91.82^{b-f}
4500	500	20.20^{ab}	1.70^{ab}	7.00^{b-d}	157.71^{a}	0.145^{h}	91.34^{d-g}
	1000	17.68^{b-d}	1.42^{a-e}	6.60^{de}	128.67^{a-d}	0.160^{e-h}	92.18^{b-f}
	2000	12.98^{f-h}	1.12^{b-e}	6.20^{e}	83.66^{c-e}	0.194^{cd}	91.62^{c-g}
	3000	13.72^{d-h}	1.28^{a-e}	6.33^{e}	57.37^{e}	0.242^{a}	91.10^{e-g}

Means followed by the same letter in each column are not significantly different by Duncan's multiple range test at 5% level.

toxic effects of Na^+ and Cl^- ions may cause the seeds to die or delay their germination, which led to a decrease in the GP. It was indicated that pretreatment by soaking the seeds in a NaCl solution increased the GP of radish seeds, as reported by Gebreegziabher and Qufa (2017). Perhaps the reason is that pretreatment by soaking the seeds in saline solutions may cause hardening of the seeds and a physiological change in the internal components of the seed. Subsequently, which results in an increased ability of the seed to absorb water and an increased tolerance to the toxic effects of salts, which helped it to grow and developed in saline conditions.

Indeed, the high level of water irrigation salinity led to reducing the FW and DW of the shoot part and LA of the plant (Table 1). Similar results were reported by Mohamed and Gomaa (2012) and Jasim et al. (2016). The decrease in vegetative growth measurements was due to the increased salinity of the irrigation water could reduce the amount of water absorbed by the roots. This event could be attributed to the increase in the osmotic pressure of the soil solution and the accumulation of salts with toxic effects on the root growth zone. Increasing the plant's absorption of some elements, such as Na and Cl ions reduced the availability of some nutrients necessary for plant growth, such as nitrogen, phosphorous and potassium. Subsequently, it negatively affected the efficiency of the photosynthesis process and caused a decrease in all vital processes (Ma et al., 2020), thus reduced plant growth.

In fact, the increase in the salinity of the irrigation water led to a decrease in the total chlorophyll content in the leaves (Figure 2). This was previously noted, whereas there was a decrease in the plant's ability to absorb the necessary nutrients, some of which enter into the formation of the chlorophyll molecule, such as nitrogen and magnesium, or have an important role in its formation processes, such as iron (Mohamad and Gomma, 2012). This decrease was due to the unavailability of these nutrients as a result of high soil pH or the replacement of harmful salts such as Na^+ in the exchange sites in the soil. In contrast, the increase in the total chlorophyll content in the leaves can be explained as a result of the plant's adaptation to growth in saline conditions. Additionally, the absorption of water and nutrients has been achieved with a higher efficiency state, which is in agreement with results mentioned by Sivritepe et al. (2005). Whereas, the pretreatment of seeds with NaCl solution increased the vegetative growth of the plant such as the FW and DW of the shoots, LN, LA and SLW (Table 1), which is consistent with results mentioned by many researchers (Cayuela et al., 2001; Sivritepe et al., 2005; Bajehbaj 2010).

The increase in plant growth may be due to the physiological changes that occurred in the plant as a result of seed pretreatment, which led to a high osmotic pressure of the plant cells and thus an increase in water absorption through the roots. This can be due to increase in

Table 2. Effect of seed soaking pretreatment in NaCl solution and salinity of irrigation on fresh weight (FW), dry weight (DW), length (LR), diameter (DR) and water content (WC) of radish roots.

Treatments		Measurements				
Conc. of seed socking solution (NaCl ppm)	Salinity of Irrigation (ppm)	FW (g/root)	DW (g/root)	LR (cm)	DR (cm)	WC (%)
0	500	7.46^{bc}	0.63$^{d\text{-}g}$	2.48$^{b\text{-}f}$	2.06$^{c\text{-}g}$	93.16^{ab}
	1000	4.24$^{c\text{-}f}$	0.43^{h}	1.78^{f}	1.64$^{e\text{-}g}$	92.81$^{a\text{-}c}$
	2000	2.88^{ef}	0.25^{h}	1.90^{ef}	1.45f^{g}	91.13$^{b\text{-}e}$
	3000	2.70^{f}	0.26^{h}	1.71^{f}	1.42^{g}	89.55^{e}
1500	500	12.86^{a}	0.84$^{a\text{-}d}$	3.42^{a}	2.66$^{a\text{-}c}$	93.96^{a}
	1000	13.12^{a}	0.82$^{a\text{-}d}$	2.40$^{b\text{-}f}$	3.13^{a}	93.91^{a}
	2000	6.20$^{c\text{-}e}$	0.70$^{c\text{-}f}$	2.44$^{b\text{-}f}$	2.00$^{c\text{-}g}$	91.12$^{b\text{-}e}$
	3000	6.80^{cd}	0.62$^{d\text{-}g}$	2.32$^{b\text{-}f}$	1.80$^{d\text{-}g}$	89.77^{de}
3000	500	10.83^{ab}	0.67$^{d\text{-}g}$	2.58$^{b\text{-}e}$	2.26$^{b\text{-}f}$	93.56^{ab}
	1000	13.55^{a}	0.79$^{b\text{-}e}$	2.36$^{b\text{-}f}$	2.43$^{a\text{-}d}$	94.20^{a}
	2000	7.07^{cd}	0.96^{ab}	2.96^{ab}	2.16$^{c\text{-}g}$	91.31$^{b\text{-}e}$
	3000	4.88$^{c\text{-}f}$	0.56$^{e\text{-}g}$	2.44$^{b\text{-}f}$	1.81$^{d\text{-}g}$	89.44^{e}
4500	500	10.88^{ab}	0.93$^{a\text{-}c}$	2.38$^{b\text{-}f}$	2.53$^{a\text{-}d}$	92.20$^{a\text{-}d}$
	1000	12.80^{a}	1.05^{a}	3.00^{ab}	3.03^{ab}	93.33^{ab}
	2000	7.00^{cd}	0.85$^{a\text{-}d}$	2.48$^{b\text{-}f}$	2.33$^{a\text{-}d}$	90.28^{de}
	3000	3.95$^{d\text{-}f}$	0.47$^{f\text{-}h}$	2.18$^{c\text{-}f}$	1.66$^{e\text{-}g}$	90.53$^{c\text{-}e}$

Means followed by the same letter in each column are not significantly different by Duncan's multiple range test at 5% level.

the proportion of important nutrients, such as potassium and calcium, and thus an increase in the efficiency of vital processes such as photosynthesis, building plant tissues, and the transpiration process. These processes greatly affected the absorption of water by opening and closing stomata. Indeed, the prior treatment may increase the proportion of some amino acids, such as proline, which accumulate when a plant was stressed to try to recover from the damage caused by it. Therefore, since the prior treatment with NaCl salt increased the WC of the plant tissue (Table 1. and 2.) and the content of chlorophyll in the leaves (Figure 2), all these factors increased the efficiency of the photosynthesis process and increased plant growth.

Indeed, the decrease in the growth measurements of the roots (Table 2) is due to the negative effects of salinity on the vegetative growth stage of the plant, the chlorophyll content of the leaves, the efficiency of the photosynthesis process, and all the vital processes related to the high osmosis, including EC and pH in the soil solution. Eventually, this led to a decrease in the FW and DW of the root, as well as the LR and DR of the root (Jamil et al., 2007; Jasim et al., 2016; de Sousa Basílio et al., 2018). Indeed, there are many studies that agree with our findings, as the pretreatment of seeds by soaking them in NaCl solution reduces the negative effect of the salinity of irrigation water (Cayuela et al., 2001; Esmaielpour et al., 2006; Tian et al., 2014). On the contrary, it increased the FW and DW of the root and the LR and DR of the root (Table 2). This effect was due to the increase in the adaptability and tolerance of the plant to the conditions of salt stress as a result of soaking the seeds in NaCl solution. Moreover, which led to an increase in the vegetative growth of the plant and an increase in the concentration of pigments involved in the photosynthesis process. Subsequently, this reflected positively on the growth of the root system and the increased in the WC of the root due to the prior treatment of seeds. Finally, it indicated that the plant has adapted to the surrounding conditions and increased its ability to absorb water more efficiently, which increases plant growth.

A decrease in the WC of the root system with an increase in the salinity of the irrigation water may be attributed to the inability of the plant to absorb a sufficient amount of water. Plant deficiency may be due to the high osmotic pressure of the soil solution due to the increase in the amount of salt dissolved in it (Yildirim et al., 2008). In contrast, the pretreatment of the seeds slightly increased the WC of the shoot and root system, which may be due to the increase in the osmotic pressure of the plant, thus enabling it to absorb more water through its roots.

Conclusion

The salinity of the irrigation water caused significant decrease in plant growth, seed germination and chlorophyll content of leaves. Soaking of seeds in NaCl solution improved the germination, chlorophyll content, and fresh and dry weight of shoot and root under salinity conditions.

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