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TOLERABILITY OF SOME POTATO CULTIVARS TO SALINE STRESS

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Abstract

The experiment was conducted in the greenhouse belonging to Al-Mussaib Technical College for the autumn season 2019 with the aim of knowing the extent of the tolerance some cultivars of potatoes for salt stress using NaCl, where the experiment included five cultivars of potatoes (BURREN, ELMUNDO, RIVIERA, SIFRA, ELBEIDA) and added salt levels with Irrigation water (0, 4, 8, 10) dS.m^{-1} and with three replicates. The experiment was conducted according to the Complete Randomized Design (C.R.D) and the significant differences between the averages were tested according to the least significant difference test (L.S.D) and at a probability level of 0.05. The results of the research showed that the increase in NaCl concentrations leads to a clear decrease in the traits of vegetative growth (plant height, leaf area and leaf content of chlorophyll) and the quantitative trait (number of tubers. plant $^{-1}$) and the cultivars BURREN and RIVIERA significantly increased in all studied traits. As for the interaction, the two combinations (BURREN cultivar with the control treatment and RIVIERA cultivar with the control treatment) recorded the highest average for all studied traits without significant difference from the two combinations (BURREN cultivar with 4 dS.m^{-1} and RIVIERA cultivar with 4 dS.m^{-1}) for all traits except for the number of tubers.

Key word: potato, salt stress, cultivars, NaCl

Introduction

The potato is one of the most important vegetable crops in the Arab world and the world, especially the Americas, due to the abundance of productivity and its tolerance to various environmental conditions, where it occupies the first place in terms of cultivated area and productivity, So the area cultivated with this crop increases by about 23 million hectares, equivalent to 46% of the total cultivated area of tuberous vegetables (FAO, 2013). Where the potato *Solanum tuberosum* is one of the plants of the Solanaceae family, which ranks fourth in the world as a food crop after wheat, rice and maize. The potato is very important because it is an important source of energy because it contains high amounts of protein and it also contains many vitamins and amino acids as it is an essential source of 18 amino acids out of 20 amino acids (Muthoni and Nyamon, 2009). Potato crop production is affected by many environmental factors, the most important of which is soil and water salinity. It is one of the environmental stresses that negatively affect the growth and productivity of this crop (Munns, 2010) and for the purpose of studying the salinity factor, there are several methods, including exposing the plants to different levels of salts by adding these salts to irrigation water and controlling the quantities added, knowing that the effect of salinity in the plant depends on the severity of the salt stress and the time of its occurrence and the length of time the plant is exposed to it and the plant growth stage (Kumar and Sinhabab, 2003) In a study by Steven and Heap (2001) on the potato yield, it decreased by 12% when the concentration of soluble salts in irrigation water increased from 640 mg.L $^{-1}$ to 704 mg.L^{-1}. and Al-Hamdani and Mohammed (2014) demonstrated that increasing the salt concentration from 1.6 to 4.3 dS.m^{-1} reduced the plant height, total chlorophyll, total yield and marketable yield. and due to the cultivation of potatoes in large areas of the world in different environmental conditions, so the environment is an important and determining factor for the growth and productivity of cultivars, where the factor is affected by the cultivar and the location of cultivation (Haase *et al.,* 2005), The introduction of new cultivars is considered a modern agricultural scientific practice necessary for the progress and development of agricultural production in any country because the productivity of the cultivars changes according to the variation of environmental factors that affect negatively or positively as a result of the genetic

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factor interaction with the environment (Aldarir and Hussein, 2008).

Materials and methods

A factorial experiment was conducted to study the effect of salt stress using NaCl on the growth and yield of 5 cultivars of potatoes. The experiment was conducted during the spring season of 2019 in the plastic house belonging to the Plant Production Department , Al-Mussaib Technical College located in the north of Babylon province, at 35 km, and the Randomized Complete Design was used with 3 replicates. The experiment included 4 concentrations of NaCl (0, 4, 8, 10) $dS.m^{-1}$ and five cultivars of potatoes (BURREN, ELMUNDO, RIVIERA, SIFRA, ELBEIDA). Added 100 kg. ha^{-1} from both P and K as a single batch before cultivated and mix thoroughly with the soil, As for the added amount of N, it was 200 kg. ha^{-1} was added in two batches, the first at germination and the second 30 days after the first batch. As for sodium chloride, it was added first after the stage of the emergence of 4 real leaves and was also added 45 days after the first stage. NPK fertilizers were added as form urea, triple superphosphate and potassium sulfate respectively. A random sample was taken from the soil to study the physical and chemical properties table 1, The following traits were studied: Plant height(cm), leaf area (cm^2), leaf content of Chlorophyll (SPAD), number of $tubers.plant^{-1}$.

Table 1: Physical and chemical properties of soil and water used in the study.

Traits	Soil	water
Sand	58	-
Clay	20	-
Silt	22	-
PH	7.4	7.3
EC	1.71 $ds.m^{-1}$	1.33 $ds.m^{-1}$

Results and Discussion

Plant height (cm)

The results in table 2 indicate a significant difference in salinity levels in the plant height (cm), where the highest average of plant height reached 60.92 cm for the control treatment, while the lowest average was 43.06 cm when treated with NaCl at a concentration of 10 $dS.m^{-1}$. The same table indicates that there were significant differences for the cultivars used in plant height, with the highest average plant height amounted to 57.23 and 56.89 cm for BURREN and RIVIERA cultivars, respectively, compared to the lowest average of 47.87 cm for the cultivar ELBEIDA. The results in the same table also indicated that there was a significant interaction between the used cultivars and salinity levels, where the BURREN and RIVIERA cultivars significantly excelled with the control treatment by giving the highest average of plant height amounted to 68.17 and 67.53 cm, compared to the cultivar ELBEIDA with a treatment at a concentration of 10 $dS.m^{-1}$, which the lowest plant height was 39.10 cm, and without significant difference from the BURREN and RIVIERA cultivars with a concentration of 4 $dS.m^{-1}$ which gave 64.40 and 58.27 cm respectively. The reason for variance between the cultivars studied under the influence of stress is due to the difference in the ability of the cultivars to maintain the fullness effort within the plant cells and then to maintain the continued elongation of the plant cells (Khrerdiev, 2000).

Table 2: Effect of cultivars and NaCl concentrations and their interaction on Plant height (cm).

Averages	Cultivars					NaCl $ds.m^{-1}$
	ELBEIDA	SIFRA	RIVIERA	ELMUNDO	BURREN	
60.92	55.63	57.27	67.53	56.00	68.17	0
56.00	53.33	53.63	58.27	50.40	64.40	4
48.67	43.40	48.30	54.63	45.17	51.83	8
43.06	39.10	41.33	47.13	43.23	44.50	10
	47.87	50.12	56.89	48.70	57.23	Averages
Nteraction		NaCl		Cultivars		L.S.D. 5%
10.786		4.824		5.393		

Leaf area (cm^2)

The results in table 3 show that there were significant differences for the NaCl levels used in the leaf area, where the highest average of the leaf area reached 4977.8 and 4826.4 cm^2 for the control and 4 $dS.m^{-1}$ treatments , respectively, compared to the lowest average of 3496.6 cm^2 for the treatment 10 $dS.m^{-1}$. The same table also indicated that there were significant differences for the cultivars used in the leaf

Table 3: Effect of cultivars and NaCl concentrations and their interaction on leaf area (cm^2).

Averages	Cultivars					NaCl $ds.m^{-1}$
	ELBEIDA	SIFRA	RIVIERA	ELMUNDO	BURREN	
4977.8	4699	4961	5319	4803	5107	0
4826.4	4515	4721	5207	4651	5038	4
4250.8	4055	4190	4448	4132	4429	8
3496.6	3261	3348	3524	3661	3689	10
	4132.5	4305	46245	4311.75	4565.75	Averages
Nteraction		NaCl		Cultivars		L.S.D. 5%
563.1		251.8		281.6		

area, where the highest average was 4624.5 and 4565.75 cm^2 for RIVIERA and BURREN cultivars, respectively and the lowest average was 4132.5 cm^2 for the cultivar ELBEIDA. As for the significant interaction between the used cultivars and salinity levels, it was noted that the highest leaf area was for the RIVIERA cultivars with control treatments and 4 $dS.m^{-1}$ where it reached 5319 and 5207 cm^2 respectively, and the lowest leaf area was 3261 cm 2 for the cultivar ELBEIDA with a salinity level 10 $dS.m^{-1}$ without differing from cultivar BURREN with control treatments and 4 $dS.m^{-1}$ where it interaction achieved 5107 and 5038 cm^2, respectively. The reason for the small leaf area is due to the lack of elongation of plant cells when they are exposed to stress, where the elongation of cells does not occur except with the occurrence of pressure from inside the cell to the outside called bloating pressure, and the lack of the occurrence of Turgor pressure leads to a slow process of elongation and division of cells and reducing their size, which is reflected Negatively on the trait of leaf area (Al-Hamzawy, 2016).

The leaf content of chlorophyll (SPAD)

The results in table 4 show that there were significant differences for the salinity levels used and their effect on the leaf content of chlorophyll, where the highest average of was 43.15 spad for treatment 0 $dS.m^{-1}$ and the lowest average was 26.73 spad at the salinity level of 10 $dS.m^{-1}$ without differing from treatment 4 $dS.m^{-1}$ which achieved average of 41.76 spad, The same table also showed that the cultivated cultivars in the experiment had a significant effect, where the BURREN and RIVIERA cultivars significantly excelled in the rest of the cultivars, so the highest average for the cultivars was 39.97 and 38.98 spad respectively compared to the cultivar ELBEIDA, which recorded the lowest average leaves content of chlorophyll 33.39 spad, As for the significant interaction, the cultivars BURREN and RIVIERA with the control treatment excelled and gave the highest average amounted to 47.97 and 46.20 spad, respectively, compared to ELBEIDA cultivar with a salinity level of 10 $dS.m^{-1}$ treatment, which recorded the lower average amounted to 24.60 spad without significant difference with interaction treatment between BURREN and RIVIERA cultivars with 4 $dS.m^{-1}$ treatment recorded 47.13 and 45.80 spad respectively. The reduced leaf content of chlorophyll is due to the negative effect of stress on the efficacy of photosynthesis as a result of partial or total closing of the stoma, which caused a lack of gas exchange, especially carbon dioxide, which negatively affected the growth of chloroplasts and this, in turn, was negatively reflected in the trait of the leaf content of chlorophyll. (Al-Saadi, 2016) or perhaps the lower chlorophyll content of plant leaves is due to the degradation of the proteins responsible for making chlorophyll A and B due to the low absorption of N by the roots in addition to a lack of absorption and transfer of ready soil water and nutrients to the plant (Al-Hamzawy, 2016).

Table 4: Effect of cultivars and NaCl concentrations and their interaction on The leaf content of chlorophyll (SPAD).

Averages	Cultivars					NaCl ds.m^{-1}
	ELBEIDA	SIFRA	RIVIERA	ELMUNDO	BURREN	
43.15	40.20	40.33	46.20	41.03	47.97	0
41.76	37.17	38.60	45.80	40.10	47.13	4
33.30	31.57	30.77	35.00	32.67	36.50	8
26.73	24.60	26.03	28.90	25.87	28.27	10
	33.39	33.93	38.98	34.89	39.97	Averages
Nteraction		NaCl		Cultivars		L.S.D. 5%
6.658		2.978		3.329		

Table 5: Effect of cultivars and NaCl concentrations and their interaction on the number of tubers.plant^{-1}.

Averages	Cultivars					NaCl ds.m^{-1}
	ELBEIDA	SIFRA	RIVIERA	ELMUNDO	BURREN	
5.258	5.090	4.800	5.767	5.001	5.633	0
4.606	4.100	4.200	4.533	4.800	5.400	4
3.939	3.633	3.800	4.333	3.733	4.200	8
3.206	2.967	3.067	3.633	3.100	3.267	10
	3.946	3.966	4.566	4.159	4.625	Averages
Nteraction		NaCl		Cultivars		L.S.D. 5%
6.658		2.978		3.329		

The number of tubers.plant^{-1}

The results in table 6 showed that the NaCl levels used in the experiment had a significant effect on the trait of the number of tubers formed, where the control treatment recorded the highest average of 5.258 tubers. plant $^{-1}$, while the treatment of 10 $dS.m^{-1}$ gave the lowest average was 3.206 tubers.plant^{-1}. The results of the same table also indicated the effect of the used cultivar to increase the number of tubers, where the cultivar BURREN excelled by giving the highest average of 4.625 tubers.plant^{-1} compared to the cultivar ELBEIDA, which gave the lowest average of 3.946 tubers.plant^{-1}, without significantly differing the first cultivar from the cultivar RIVIERA which gave an average of 4.566. The results in the table also showed that there were significant differences between the treatments in the above traits, so that the interaction of the two experiment factors positively affected the increase in the number of tubers, where the combination (RIVIERA with the control treatment) achieved the highest average amounted to 5,767 tubers.plant^{-1}, while the combination (ELBEIDA cultivar with 10 dS.m^{-1}) gave the lowest average was 2.967 tubers.plant^{-1} and the first combination did not differ from the two combinations (BURREN cultivar with control treatment) and (BURREN cultivar with 4 dS.m^{-1}) that recorded 5.633 and 5.400 tubers. plant^{-1} respectively. The reason for the excelled of the BURREN cultivar may be due to the difference in its genetic characteristics differ from the rest of the cultivated varieties in the experiment and its excelled to all vegetative growth traits. As for the decrease in the number of tubers in the plant when exposed to stress, it is due to a change in physiological processes that occur in the plant as a result of exposure to stress and the lack of ready water, which negatively affects the biological processes in the plant (Shas and Lenoble, 2002) and this is confirmed by the results of table 2, 3 and 4.

References

Agriculture Organization of the United Nations (FAO), the International Fund for FAO (2013). Required citation: FAO, I FAD and WFP. 2013. Roma.Italy.

Aldarir, Abdel Nasser and Marwan Al-Hajj Hussein (2008). Irrigation and agricultural drainage (Section Theoretical) Directorate of Books and University Publications - Faculty of Agriculture - University of Aleppo, Syrian Arab Republic.

Al-Hamdani, Sobeih Abdul Wahab and Muhammad Salman Muhammad (2014). The effect of salinity of irrigation water and spraying with amino acids (proline and arginine) on growth and yield of potatoes *Solanum tuberosum* L. *Diyala Journal of Agricultural Sciences,* **163-154(2):** 6.

Al-Hamzawy, Majeed Kazem Abbas (2016). Abiotic stress in plants. First edition. the library National Publishing and Distribution. 587 pages.

Al-Saadi, Abbas Jassim Hussein (2016). The relationship between water stress, silicium, and dacinolide hormone in some indicators of vegetative growth and the content of elements in the *Coriandnum sativum* L. *Ibn Al-Haytham Journal of Pure and Applied Sciences,* **29(2):** 376-385.

Haase, T., T. Krause, N.U. Haase, H. Bohm, R. Loger and J. He (2005). Effect of location and cultivar on yield and quality of organic potatoes for processing to crisps. Abstracts of 16th Triennial Conference of the EAPR., Bilboa, pp: 699-703.

Khrerdiev, A. (2000). Studies on salt tolerance and its mechanism in potato. *Jiangsu J. Agric. Sci.,* **9(1):** 8-12.

Munns, R. (2010). Salinity and plant tolerance. Electronic Publishing, Utah State University Extension.

Muthoni, J. and D.O. Nyamongo (2009). A review of constraints to water Irish potatoes production in Kenya. *Journal of Horticulture and Forestry,* **1(7):** 98-102.

Shas, P.R.E. and M.E. lenoble (2002). ABA, ethylene and control of sheet growth under water stress. *J. Exp. Bot.,* **53(366):** 33-37.

Sinhabab, K. and H. Kumar (2003). *The effect of salt stress on photosynth electron transport,* **38(4):** 481-485.

Steven, R. and M. Heap (2001). Saline irrigation water - an Australian perspective. http://www.sardi.sa.gov.ar.