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Effect of Soaking with Antioxidants on Seedling Growth *sorghum biocolor* l. Under Different Salinity Conditions

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Abstract

The current study was carried out in the laboratories of the Department of Life Sciences - College of Education for Pure Sciences / University of Diyala from the period (20-2-2023) until (10-4-2023). The study included cultivation in plastic pots 5kg mastic in sandy soil with the aim of studying the effectiveness of soaking with antioxidants and its effect on reducing salt stress on the growth characteristics of the white corn plant *(Sorghum biocolor* L.) Which is known as sorghum and belong to poaceae. A factorial experiment was carried out with three treatments according to a randomized complete block design (RCBD) with three replications. The first factor was soaking with ascorbic acid at a concentration of 150 mg.L.$^{-1}$, the second factor with vitamin-E, and the third factor with proline at a concentration of 150 mg.L $^{-1}$(where the materials were purchased from the AL-Shamoua office chemical supplies located in Baghdad), And irrigation with saline concentrations included, 2, 4, 6, and 8 of sodium chloride NaCl (g.L^{-1}) solution, the results showed no significant effect of these treatments on average plant height, flag leaf area, and wet weight of the rootstock, and the results showed a significant superiority when irrigating with saline concentrations of 2NaCl . The average plant height and flag leaf area were 13.11 cm, and 4.5556 cm^2 respectively, the results showed that the between the soaking materials and the irrigation water salinity concentrations had a significant effect on all growth traits, as it gave the highest average of the physiological response with the vitamin-E soaking treatment, which reached 14.33 cm in the average plant height, and the irrigation water salinity concentration was

Academic Science Journal

g.l^{-1} 4NaCl ,And the highest average overlap with vitamin-E was 5.6667 cm^2 In the average area of the flag leaf and the irrigation water salinity concentration is, And the highest average overlap with the treatment of soaking with vitamin-E was 0.4900 gm 2NaCl g.l^{-1} in the average fresh weight of the root system and the irrigation water salinity concentration was 4NaCl g.l.$^{-}$.

Keywords: antioxidants, ascorbic acid, proline, vitamin-E, NaCl, white corn .

تاثير النقع بمضادات الاكسدة في نمو بادرات الذرة البيضاء *Sorghum biocolor* L. تحت ظروف ملحية مختلفة

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الخلاصة

نفذت هذه الدراسة في مختبرات قسم علوم الحياة – كلية التربية للعلوم الصرفة/ جامعة ديالى من الفترة(20-2-2023 -10-4-2023) ولغاية واشتملت الدراسة الزراعة بالاصص البلاستيكية سعة 5 كغم في تربة ذات نسجة رملية Sandy بهدف دراسة فاعلية النقع بمضادات الاكسدة واثره في التقليل من الاجهاد الملحي في صفات النمو لنبات الذرة البيضاء *Sorghum biocolor* L. . نفذت تجربة عاملية ذات ثلاث معاملات عل وفق تصميم القطاعات العشوائية الكاملة RCBD وبثلاث مكررات ، العامل الاول النقع بحامض الاسكوربيك بتركيز 150 ملغم .لتر $^{-1}$ ، والعامل الثاني بفيتامين-E ، والعامل الثالث بحامض البرولين بتركيز 150 ملغم .لتر $^{-1}$(حيث تم شراء مواد النقع من مكتب الشموع للمستلزمات الكيميائية الكائن في بغداد) والري بتراكيز ملحية شملت 2 و4 و6 و8 من محلول كلوريد الصوديوم NaCl ، اظهرت النتائج عدم وجود تاثير معنوي لهذه المعاملات في كل من متوسط ارتفاع النبات ومساحة ورقة العلم والوزن الطري للمجموع الجذري ، واظهرت النتائج وجود تفوق معنوي عند الري بتراكيز ملحية من كلوريد الصوديوم بتركيز 2NaCl في متوسط ارتفاع النبات ومساحة ورقة العلم والتي بلغت 13.11 سم و4.5556 سم^2 على التوالي ، واظهرت النتائج ان التداخل بين مواد النقع وتراكيز ملوحة ماء الري قد اثر معنويا في جميع الصفات ، اذ اعطى اعلى متوسط للتداخل بمعاملة النقع بفيتامين-E بلغ 14.33 سم في متوسط ارتفاع النبات وبتركيز ملوحة ماء الري 4NaCl غم .لتر$^{-1}$ ، واعلى متوسط للتداخل بمعاملة النقع بفيتامين-E بلغ 5.6667 سم^2 في متوسط مساحة ورقة العلم وبتركيز ملوحة ماء الري 2NaCl غم .لتر$^{-1}$، واعلى متوسط للتداخل بمعاملة النقع بفيتامين-E بلغ0.4900 غم في متوسط الوزن الطري للمجموع الجذري وبتركيز ملوحة ماء الري 4NaCl غم .لتر$^{-}$.

الكلمات المفتاحية: مضادات الاكسدة، حامض الاسكوربيك، فيتامين-E، كلوريد الصوديوم، الذرة البيضاء.

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Introduction

The white corn crop (*Sorghum bicolor* L.) One of the important fodder crops in Iraq in particular and in the world in general, and it is one of the C4 crops belonging to the Poaceae family. Poaceae and, which comes in the fifth rank among the grain crops in the world after wheat, rice, maize and barley [1]. The cultivation of white corn is spread in many countries of the world, including India, Pakistan, Iran, Egypt and Iraq [2] [3]. Ascorbic acid is a sugary acid, as it has an effective role in transporting electrons across the plasma membrane as well as its role in cell elongation and division, as it controls cell growth [4].This acid has a role in protectio Crops from exposure to environmental stresses such as salt stress, so it can be described as an antioxidant in plants [5].The high concentration of ascorbic acid is found in chloroplasts, where its primary role is to protect against the effect of free radicals [6].Ascorbic acid acts as an auxinic, anti-toxin , and has an important role in increasing flowering and productivity [7].

Alpha-tocopherol, known as vitamin-E, is a fat-soluble antioxidant compound, present in a high percentage at the membrane level and inhibiting the chain reaction of lipid peroxidation [8]. It works to protect the plant from the effect of oxidative stress resulting from salt stress, and it also works to protect the cell membrane, as it maintains its structure and functions against active oxygen species during stress, and this in turn increases the absorption of nutrients [9].

Proline acid is one of the important amino acids that exist freely and contains a secondary amine group attached, and this feature distinguishes it from other amino acids [10].It aggregates due to the inability of plant tissues to synthesize protein as well as catabolism [11]. And it maintains the colloidal properties of intracellular protoplasm [12]. It maintains the enzymes present in the mitochondria [13].

The aim of the current study was evolution of the physiological response to salt strees on the germination and growth of white corn seeds *Sorghum biocolor* L. (Moench) after soaking with some antioxidant such as ascorbic acid, vitamin-E, and proline.

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Materials and Methods

The current was carried out in the laboratories of the Department of Life Sciences - College of Education for Pure Sciences / University of Diyala from the period (28-2-2023) until(29 -4-2023). The study included cultivation in plastic pots in a sandy soil with the aim of studying the effect of soaking with antioxidants and its effect on reducing salt stress on the growth characteristics of *Sorghum biocolor* L. Some of the physical and chemical properties of the study soil were conducted in the University of Diyala / College of Agriculture, Department of Soil and Water Resources / Graduate Studies Laboratories. of salts from the agricultural nursery and its E.C reading was 441 ds.m^{-1}After that, it was air dried and passed through a sieve with holes of 2.5 mm in diameter. The soil was well homogenized.

A factorial experiment was carried out with three treatments according to a randomized complete block design (RCBD) with three replications, where the soaking materials were dissolved in distilled water without heating with a vitamin-e and then shifted with distilled water after exposing it to heating 1000 mg beaker and placing it on a heating device (hot blate at laboratory temperature).The first factor was soaked with ascorbic acid at a concentration of 150 mg.L.$^{-1}$, the second factor with vitamin-E, and the third factor with proline acid at a concentration of 150 mg.l^{-1} And irrigation with four levels of salinity, including 2, 4, 6, and 8 of NaCl solution. Traits were studied. The mean plant height, flag leaf area, and fresh weight of the rootstock were all studied and dry weight of the root total.

Table 1: Properties for experimental soil

Unit	measurement	Adjectives
-	8.22	PH
Desi Siemens. M^{-1}	441	E.C
micro siemens. poison^{-1}	1.61	E.C for distilled water
micro siemens. poison^{-1}	105.1	E.C NaCL at a concentration of 2 g.L^{-1}
micro siemens. poison^{-1}	713	E.C NaCL at a concentration of 4 g. L^{-1}
micro siemens. poison^{-1}	1162	E.C NaCL at a concentration of 6 g. L^{-1}
micro siemens. poison^{-1}	1789	E.C NaCL at a concentration of 8 g. L^{-1}

Table 2: Properties for experimental irrigation water

$GM.KM^{-1}$	%95.8	THE SAND	SEPARATED THE SOIL
$gm.km^{-1}$	%4	Silt	
$gm.km^{-1}$	%0.2	Clay	
Sandy			Soil texture

1. Studied traits

1.1 Plant height (cm).

The plant height was measured from the soil surface to the top of the plant using a tape measure[14].

1.2 Flag left area (cm^2).

The left area was calculated at the same period based on [15], and according to the following equation:

$$\text{leaf area } (cm^2) = \text{leaf length (cm)} \times \text{leaf width at the middle (cm)} \times 0.95$$

1.3 Wet weight of the root system (g).

The wet weight of the shoots was calculated using a sensitive scale, where the rootstock was cleaned and washed well with water, and then measurements were taken.

1.4 Dry weight of the root system (g).

The dry weight of the root system was calculated using a sensitive balance, after the root system was dried for each pot for 72 hours aerobically.

2. Statistical analysis

The obtained data were analyzed according to the analysis of variance method for a completely randomized design using the ready-made statistical program (SPSS) version 22, and the Duncan test was chosen to compare the means at the level of probability 0.05[16].

Results and Discussion

1. Plant height (cm).

The results in Table (3), Were shown no significant differences for soaking treatments in the traits averages Characteristic of the average plant height of white corn seedlings, while a

significant difference was observed in the irrigation water salinity concentrations, given the irrigation water salinity concentratio 2 g.L $^{-1}$ The highest mean was 13.11 cm, while the irrigation water salinity concentration was 8 g.L $^{-1}$. less An average of 3.11 cm, and this is due to the fact that the increasing concentrations of salinity led to a decrease in plant height [17].

In results of the same table also indicate that there are differences in the average overlap between soaking materials and irrigation water salinity concentrations, as the highest average overlap with vitamin-E soaking materials was 14.33 cm, and the irrigation water salinity concentration was 4 g.L $^{-1}$. , with a lower averageTo overlap with ascorbic acid soaking materials of 2.33 cm and the salinity concentration of the irrigation water 8 g.L $^{-1}$.

Table 3: The effect of soaking materials on the average height for salinity-stressed corn seedling

Average	Soaking materials			**Salinity of irrigation water (gm.L^{-1})**
	Proline **150 mg.** L^{-1}	vitamin E **150 mg.** L^{-1}	ascorbic acid **150 mg.** L^{-1}	
13.11A	10.67b	14.00ab	14.67a	2 gm. liter^{-1}
13.00A	12.67ab	14.33ab	12.00ab	4 gm. liter^{-1}
4.33B	3.67c	4.00c	5.33c	6 gm. liter^{-1}
3.11C	3.67c	3.33c	2.33c	8 gm. liter^{-1}
8.39	7.67A	8.92A	8.58A	Average

Means with similar letters within the columns of single factors or averages of overlap are not significantly different from each other at the probability level of 0.05 according to Duncan's multiple test.

2. Flag left area (cm^2).

The results are shown in Table (4).There were no significant differences for the soaking treatments .The average area of the flag leaf (cm^2) for white corn seedlings, while a significant difference was observed in the irrigation water salinity concentrations, the irrigation water salinity concentration was 2NaCl g.l.$^{-1}$ The highest mean was 4.5556 cm^2 , while the irrigation water salinity concentration was 8NaCl g.l^{-1} The lowest average was 0.2956 cm^{2}This is due to the fact that the lower the sodium chloride concentration, the larger the flag leaf area, and that

the increase in salt causes a decrease in most of the germination and growth indicators [18].Increasing salts to high levels causes plant toxicity, which leads to a reduction in the leaf area of the plant [19].

The results of the same table indicate that there are differences in the average overlap between soaking materials and irrigation water salinity concentrations, as the highest average overlap with soaking materials with vitamin-E reached 5.6667 cm.^{2} And the irrigation water salinity concentration is 2 NaCl g.l^{-1} , with a lower averageTo overlap with soaking materials with vitamin-E and proline acid, 0.1900 cm^2 And the salinity concentration of the irrigation water 8NaCl g.l^{-1}.

Table 4: The effect of soaking materials on the average area of the flag left for salinity-stressed corn seedling

Average	Soaking materials			**Salinity of irrigation water (gm.L^{-1})**
	Proline **150 mg.** L^{-1}	vitamin E **150 mg.** L^{-1}	ascorbic acid **150 mg.** L^{-1}	
4.5556A	3.6000ab	5.6667a	4.4000ab	2 gm. liter^{-1}
3.9222A	3.0333b	4.5000ab	4.2333ab	4gm. liter^{-1}
0.5167B	0.3467c	0.5700c	0.6333c	6 gm. liter^{-1}
0.2956B	0.1900c	0.1900c	0.5067c	8 gm. liter^{-1}
2.3225	1.7925A	2.7317A	2.4433A	Average

Means with similar letters within the columns of single factors or averages of overlap are not significantly different from each other at the probability level of 0.05 according to Duncan's multiple test.

3. Fresh weight of the root system (gm).

The results are shown in Table (5).There were no significant differences for the soaking treatments Characteristic of the average fresh weight of the root total (gm) of white corn seedlings, and it was observed that there was no significant difference in the irrigation water

salinity concentrations, due to the fact that antioxidants are substances that can scavenge free radicals directly or indirectly[20], and that Stimulating seeds with low concentrations prevents

or hinders the oxidation of some vital compounds such as lipids, carbohydrates and nucleic acids [21].

The results of the same table indicate that there are differences in the average interaction between the soaking materials and the irrigation water salinity concentrations, as the highest average of the interaction with the soaking materials with vitamin-E was 0.4900 g, and the irrigation water salinity concentration was 4NaCl g.l.$^{-1}$, with a lower averageTo interfere with proline acid 0.1233 gm and the irrigation water salinity concentration 8NaCl g.l^{-1}

Table 5: The effect of soaking materials on the average wet weight of total root for salinity-stressed corn seedling

Average	Soaking materials			**Salinity of irrigation water (gm.L^{-1})**
	Proline **150 mg.** L^{-1}	vitamin E **150 mg.** L^{-1}	ascorbic acid **150 mg.** L^{-1}	
0.2922 A	0.2867 ab	0.306 ab	0.2833 ab	2 gm. liter^{-1}
0.3267 A	0.2300 ab	0.490 a	0.2600 ab	4 gm. liter^{-1}
0.2011 A	0.1500 ab	0.1833 ab	0.2700 ab	6 gm. liter^{-1}
0.2578 A	0.1233 b	0.350 ab	0.3000 ab	8 gm. liter^{-1}
	0.1975 A	0.3325 A	0.2783 A	Average

Means with similar letters within the columns of single factors or averages of overlap are not significantly different from each other at the probability level of 0.05 according to Duncan's multiple test.

4. The dry weight of the root system (g).

The results are shown in Table (6).There were no significant differences for the soaking treatments Characteristic of the average fresh weight of the root total (gm) of sorghum seedlings, and it was observed that there was no significant difference in the irrigation water salinity concentrations, and the reason for this is attributed to the fact that antioxidants have a role in protecting crops from exposure to environmental stresses such as salt stress [4].

The results of the same table indicate that there are no significant differences in the average interaction between soaking materials and salinity concentrations of irrigation water.

Table 6: The effect of soaking materials on the average dry weight for salinity-stressed corn seedling

Average	Soaking materials			Salinity of irrigation water (gm.L^{-1})
	Proline 150 mg. L^{-1}	vitamin E 150 mg. L^{-1}	ascorbic acid 150 mg. L^{-1}	
0.0511A	0.0233cd	0.0700a	0.0600ab	2 gm. liter^{-1}
0.0444A	0.0433bc	0.0500ab	0.0400bc	4 gm. liter^{-1}
0.0167B	0.0100d	0.0133d	0.0267cd	6 gm. liter^{-1}
0.0122B	0.0133d	0.0100d	0.0133d	8 gm. liter^{-1}
	0.0225B	0.0358A	0.0350A	**Average**

*** There are no statistically significant differences between the two factors of the study and the intervention between them**

Conclusions and suggestions

Conclusions

1- The plant type white corn (C4) exhibited a similar behavior towards the soaking materials (non-enzymatic antioxidants), and it was found in the pot experiment that the white corn was less responsive to the soaking materials.

2- The results showed that sorghum tolerates salinity at different concentrations, especially when the seeds are soaked before planting with non-enzymatic antioxidants.

3- The significant interactions between the treatments of soaking seeds with non-enzymatic antioxidants and irrigation with an increasing concentration of sodium chloride salt indicate that the soaking treatments behaved differently towards the irrigation treatments, as the irrigation was with a concentration of 2 g of NaCl liter.$^{-1}$ with the best results.

Suggestions

1. Conducting this study in the field and with larger areas of pots.
2. Treating seeds of other hosts before planting with enzymatic antioxidants to improve their ability to withstand soil salinity stresses and irrigation water.
3. Anatomical study of plant seedlings treated with antioxidants to identify changes in their cells as a result of these treatments and the increase in salinity in their tissues.

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