INTERNATIONAL STANDARD SERIAL NUMBER eISSN: 2789-858X

SCIENTIFIC JOURNAL FOR THE FACULTY OF SCIENCE - SIRTE UNIVERSITY

VOLUME 3 ISSUE 2 OCTOBER 2023

DOI: 10.37375/issn.2789-858X - Indexed by Crossref, USA

Bi-annual, Peer- Reviewed, Indexed, and Open Accessed e-Journal

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Scientific Journal for the Faculty of Science-Sirte University Vol. 3, No. 2 (2023) 105-109

Scientific Journal for the Faculty of Science-Sirte University

Journal home page: http://journal.su.edu.ly/index.php/JSFSU/index

DOI: 10.37375/issn.2789-858X

The Evaluation of Tolerance of Six *Triticum aestivum* Genotypes to Salt Stress

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DOI: https://doi.org/10.37375/sjfssu.v3i2.1612

ARTICLE INFO:

Received: 09 August 2023

Accepted: 09 October 2023

Published: 26 October 2023

Keywords: Triticum aestivum, Bread wheat, Durum wheat, Salinity tolerance, Salt stress

A B S T R A C T

Soil salinity is one of the most environmental important obstacles facing the productivity and quality of wheat crops, However, the adverse effects of salinity could be mitigated by identifying salinity-tolerant genotypes. Therefore, this study was conducted with an aim of Evaluation of the tolerance of six Acsad wheat genotypes to salt stress, (Acsad 1398, Acsad 1508, and Acsad 1524) of bread wheat, and (Acsad 1595, Acsad 1671, and Acsad 1729) of durum wheat, under five levels of salt treatments (0, 50, 100,150, and 200 NaCl). The results indicate that salinity levels reveal significant ($p \leq 0.05$) differences in germination percentage, radical /plumule length, and seedling fresh weight. In addition, there were non-significant differences in the average of germination time. As noted genotype the A1508 genotype scored the highest average germination percentage reached (90.6 %), while genotype A1595 was superior to others in an average of radical /plumule length, and seedling fresh weight. Also, the result indicated that 200 mM NaCl of salinity stress was the most toxic for all wheat genotypes included in this study. finally, the results of this study categorize the wheat genotypes into tolerant genotypes include (A1508 and A1595), moderate tolerant genotypes include (A1398) and sensitive genotypes include (A1671, A1524, and A1729).

1 Introduction

In Libya, wheat (*Triticum aestivum* L.) ranks first in terms of planted area with about 165,000 ha and an annual yield of 200,000 tons (Alabasi *et al*., 2017) major staple food crop that provides fiber, proteins, vitamins, lipids, and minerals (Sabenca *et al*., 2021). Salinity is one of the most important environmental stresses, which threatens the growth and productivity of agricultural crops (Salih and Abdulrraziq, 2023), where believed that by 2050, areas affected by salinity are expected to cover about 50% of total land agriculture (Kumar *et al*., 2020). Soil salinity affects adversely seed germination, plant growth, photosynthesis, stomatal conductance, reproductive behavior, amino acid biosynthesis, and enzymatic activity, In addition, change physicochemical properties and reduces the microbial diversity of the soil (Kesh *et al*., 2022; Kumar *et al*., 2020), by ionic toxicity, osmotic stress, disruption of cellular homeostasis, nutrient mobilization reduction, and overproduction (ROS) like superoxide anion (O_2-), hydrogen peroxide (H_2O_2), and hydroxyl radicals (OH) in chloroplast and mitochondria (Riseh *et al*., 2021; Naveen *et al*., 2023). Identification of tolerant genotypes, capitalizing on adaptive traits, is considered one method that contributes to salinity stress tolerance and improved productivity (Ehtaiwesh, 2019), for example, a study conducted in Pakistan, on 125 genotypes of wheat germinated under salt stress In vitro, it was found 11 genotypes tolerant, 38 genotypes moderate tolerant, 48 genotypes moderate sensitive, and 28 genotypes sensitive (Khan *et al*., 2022), in

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Turkey, a study concluded by Oner and Kirli (2018) concluded the negative effect of salinity on germination times, seedling growth, and radicle weights and lengths of 7 different bread wheat cultivars, as confirmed results of a study in Libya, that wheat cultivars Sabha, Salambo, Makkawi, and Bushi were the most salt-tolerant out of the 12 genotypes (Ehtaiwesh and Rashed, 2019).

Therefore, the objective of this study was to evaluate salinity tolerance of six wheat genotypes.

2 Materials and Methods

2.1. Seed Selection

The laboratory study was conducted in the Department of Biology/Faculty of Education/Omar Al-Mukhtar University. Six genotypes of wheat were used. three genotypes of bread wheat (Acsad 1398, Acsad 1508, and Acsad 1524) and three genotypes of durum wheat (Acsad 1595, Acsad 1671, and Acsad 1729) were obtained from Arab center for the studies of arid zones and dry lands Acsad. Cleaned of impurities, and viability was tested by soaking in distilled water to get rid of empty seeds floating on the surface, were soaked in 1% sodium hypochloride solution for 3 minutes, and washed with distilled water (Salih *et al*., 2022).

2.2. Preparation of Used Solutions

The brine was prepared using sodium chloride salt (0, 50, 100,150, and 200 mM (NaCl) as follows:

1m Mol = molecular weight of the solute / 1000 * concentration

50 m Mol= molecular weight of the solute /1000 *50

50 m Mol=58.5 / 1000* 50

50 m Mol=2.925 g/L

Dissolve 2.925 g of NaCl salt in a 1000 ml volumetric flask and add distilled water to the mark, repeat the same previous steps for the rest of the concentrations.

2.3. Seed Germination

Normally, 10 seeds per Petri dish, were lined with two Whatman No.1 filter papers and incubated at room temperature. Each treatment was repeated three times, dishes were subjected to daily observation for 10 days and follow-up of germination in terms of addition of saline solution to the treated dishes. Distilled water was added to control as needed for each dish (Othman *et al*., 2018). The filter papers were changed once every two days to prevent salt accumulation due to evaporation, Germination was calculated by recording the number of germinated seeds in all treatments starting from the second day, which the first germination occurred, germination criterion is the appearance of radical outside seed cover at end of the experiment took final results of following qualities :

Germination percentage (PG %) = number of germinated seeds / total number of seeds cultured × 100 (Yousif *et al*., 2020).

Mean germination time (MGT) = The total number of germinated seeds per day / total number of germinated seeds at end of the experiment (Salih and Abdulrraziq, 2018).

Radical and plumule lengths (cm): The root and plumule lengths were taken using a graduated ruler, and the averages were calculated by taking 5 seedlings from each plate.

Fresh weight of seedling (g): The weight 5 of the seedlings of each dish was taken and the averages were taken.

Statistical Analysis

The study experience was designed according to the complete random design (CRD). Statistical analysis was performed using Minitab 17 program and ANOVA variance analysis tables. The averages were compared using Tukey's test at P <0.05.

3 Results

3.1. Effects of Salinity on Germination Percentage and Mean Germination Time

The results presented in Table (1) and (2), Fig (1) and (2), represented the effect of salinity levels (0, 50, 100, 150, and 200 mM NaCl) on germination percentage and mean germination time after 10 days of germination. The recorded data showed significant differences in a decrease in germination percentage of six wheat genotypes. Where the lowest averages percentage of germination was recorded for genotypes Acsad1729, Acsad1524, and Acsad1671 from 100% for control to (61.2, 62.6, and 67.2%), and with an increase in means germination time from 3.5 days for control to (4.3, 3.9 and 4.2days) respectively. Also, caused a high concentration (200 mM) suppressed all seed growth for all wheat genotypes included in this study. The results showed that the percent germination of the genotypes (Acsad1595 and Acsad1398) was not affected at 50 and

100 mM., but decreased by (90 and 65%) at 150 mM, and (40 and 20%) at 200 mM, compared to the control of these two genotypes respectively, also this level of salinity stress caused a delay in an average germination time from (3.4 days) and (3.2 days) for control to (4.0 days) and (4.2 days) for these two genotypes respectively. The results also showed that in genotype Acsad1508 the germination percentage was not affected at 50, 100, and 150 mM, but decreased by (53%) at 200 mM, also the same level of salinity caused a delay in an average germination time from (3.2days) for control to (3.7 days).

Table (1): The effect of salinity levels on germination percentage (%) of six wheat genotypes.

Genotypes	NaCl (mM)					Genotypes average
	Control	50	100	150	200	
A1398	100	100	100	65	20	77.0 bc
A1508	100	100	100	100	53	90.6 a
A1524	100	100	80	33	0.0	62.6 d
A1595	100	100	100	90	40	86.0 ab
A1671	100	100	90	46	0.0	67.2 cd
A1729	100	100	80	26	0.0	61.2 d

Table (2): The effect of salinity levels on mean germination time of six wheat genotypes (day).

Genotypes	NaCl (mM)					Genotypes average
	Control	50	100	150	200	
A1398	3.2	4.0	4.2	4.7	5.2	4.2 a
A1508	3.2	3.5	3.8	4.3	4.6	3.7 a
A1524	3.5	4.5	5.4	6.5	0.0	3.9 a
A1595	3.4	3.7	4.0	4.5	4.8	4.0 a
A1671	3.5	5.1	5.8	6.7	0.0	4.2 a
A1729	3.5	5.2	6.3	6.9	0.0	4.3 a

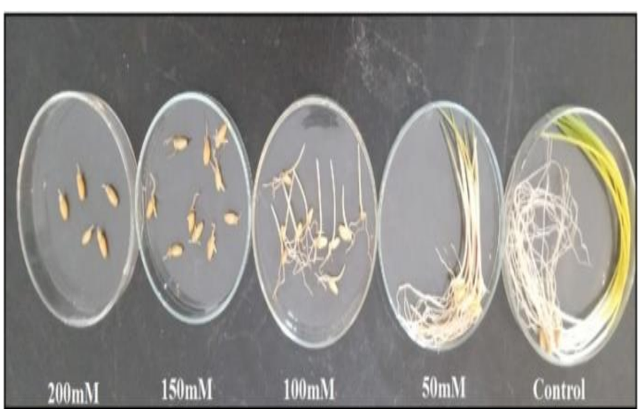

Figure (1): The effect of salinity levels on germination rates of genotype Acsad 1508.

Figure (2): effect of salinity levels on germination rates of genotype Acsad1595.

3.2. Effects of salinity on shoot and plumule length

The results presented in Tables (3 and 4) of six wheat genotypes showed significant differences in shoot and plumule length. Where the lowest average of radical length was recorded at (2.3, and 2,7cm), for genotypes (Acsad1524, and Acsad1729) respectively. However, for the rest of genotypes the radical lengths ranging between (3.5, and 5.6cm), Acsad1595 was the best among them.

Table (3): The effect of salinity levels on radical length (cm) of six wheat genotypes.

Genotypes	NaCl (mM)					Genotypes average
	Control	50	100	150	200	
A1398	9.2	6.5	1.3	0.4	0.2	3.5 cd
A1508	11.5	9.3	2.0	0.7	0.2	4.7 b
A1524	7.5	5.6	1.0	0.4	0.0	2.3 e
A1595	12.6	10.0	4.2	1.2	0.3	5.6 a
A1671	9.4	6.8	2.2	0.6	0.0	3.8 c
A1729	8.2	4.5	1.0	0.2	0.0	2.7 de

As noted, the lowest average plumule length (3.8, 4.0, and 4.2cm) for genotypes (Acsad1729, Acsad1671, and Acsad1524), respectively, and the value increased to (5, 6, and 7), for Acsad1398, Acsad1508, and Acsad1595 respectively.

Table (4): The effect of salinity levels on Plumule length (cm) of six wheat genotypes.

Genotypes	NaCl (mM)					Genotypes average
	Control	50	100	150	200	
A1398	11.7	10.0	2.6	0.5	0.3	5.0 ab
A1508	13.4	11.3	3.7	1.2	0.4	6.0 ab
A1524	10.5	7.5	3.0	0.4	0.0	4.2 b
A1595	15.0	11.2	6.9	1.6	0.3	7.0 a
A1671	9.5	7.2	3.1	0.2	0.0	4.0 b
A1729	9.9	8.0	1.2	0.3	0.0	3.8 b

3.3. Effects of Salinity on Seedling Fresh Weight

The results in Table (5), of six wheat genotypes, showed significant differences in average seedling fresh weight. Where the highest average of seedling fresh weight was recorded (1.43g), for A1595, followed by A1508 (1.30 g), while the remaining genotypes had an average seedling fresh weight ranging between (0.91 and 1.14 g), A1729 and A1671 were the lowest genotypes.

Table (5): The effect of salinity levels on seedling fresh weight (g) of six wheat genotypes.

Genotypes	**NaCl (mM)**					**Genotypes average**
	Control	50	100	150	200	
A1398	2.50	1.65	0.90	0.54	0.13	1.14 c
A1508	2.87	1.80	1.04	0.86	0.15	1.30 b
A1524	2.33	1.71	0.82	0.40	0.0	1.05 cd
A1595	2.94	2.10	1.09	0.73	0.32	1.43 a
A1671	2.41	1.32	0.78	0.35	0.0	0.97 de
A1729	2.43	1.20	0.80	0.12	0.0	0.91 e

4 Discussion

Wheat (*Triticum aestivum* L.) occupies nearly 200 million hectares with a global production of approximately 716 million tons, the second most important cereal crop in the world (Mamrutha *et al.*, 2019). However, wheat crops suffer physiological and biochemical changes when exposed to salt stress, which leads to a decrease in yield and productivity (Masarmi *et al.*, 2023; Khalid *et al*., 2023). Therefore, this study was conducted on the verification of tolerance of six Acsad wheat genotypes to salt stress. Which showed highly significant differences when ($P < 0.05$) in reducing germination percentage, lengths of radical and shoot, and decreasing seedling fresh weight in wheat genotypes included in this study compared to control, by salinity stress. Different germination rates were reported for genotypes of wheat for salinity tolerance (Uzair *et al*., 2022; Quan *et al*.,2021). May be attributed to osmotic and ion-specific toxic effects, which reduce the amounts of seed germination stimulants such as GAs, enhancing ABA amounts, and reducing seed absorption of water, also Na^+, can replace the K^+ cation and promote ion toxicity, which changes the permeability of the membranes and damage (Assaha *et al*., 2017; Adhikari *et al*.,2022). Moreover, the A1508 genotype scored the highest average germination percentage reached (90.6 %), while genotype A1595 was superior to others in average Radical /Plumule length, and seedling fresh weight. Also, the study found that concentration of 200 mM NaCl is the most toxic to all genotypes. Our results categorize wheat genotypes included in this study into tolerant (A1508 and A1595), moderate tolerance (A1398), and sensitive (A1671, A1524, and A1729). The different behavior of genotypes in salinity tolerance could be attributed to genetic variation (Munns and Tester, 2008; Al-Ashkar *et al*., 2020).

5 Conclusion

In this study, Six genotypes from the Arab Center for the Studies of arid and dry lands (Acsad) were investigated for their tolerance to different levels of salinity. Salinity reduced all the studied traits of the genotypes. The study categorizes the wheat genotypes into tolerant (A1508 and A1595), moderate tolerance (A1398) and sensitive (A1671, A1524 and A1729). The authors concluded that salt tolerance depends on their wheat genotype.

Conflict of Interest: The authors declare that there are no conflicts of interest.

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