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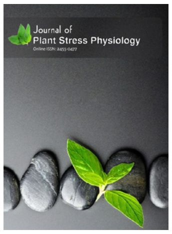
Research Article



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Exploring the tolerance of Iraqi wheat varieties: Evaluating seed germination and early growth of six Iraqi wheat varieties under salinity stress

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ABSTRACT

Abiotic stresses reduce the production of crops by 50% which significantly affects the food security globally. Plant growth and development are affected by salinity stress, Salt stress affects about 19.5% of irrigated lands and 2.1% of drylands which is expected to rise in the future. Wheat *Triticum aestivum* is classified as one of the most significant crop globally besides maize and rice which significantly contribute as a part of daily calories and proteins and it ranked first for its values in domestication and staple food. The purpose of the study was to assess how well various wheat genotypes tolerated salinity under various salinity concentrations, and the varieties were (Iba99, Hadbaa, Hashmiaa, Al-Rasheed, Sham, and Rabiaa). Different NaCl concentrations were used (50, 100, 150, and 200 mM) and Measurements were made on germination %, shoot length, fresh weight, and dried weight. Iba99, Sham and Rabiaa were the best varieties where the seed germination was 100% and other varieties differed slightly (Hadbaa 40, Hashmiaa 80 and Al-Rasheed 60%). The growth parameters results demonstrated that all the shoot lengths and fresh and dry weights were affected by the salinity stress and the correlation was inverse. It was decreased with the NaCl concentration increase. Rabiaa and Iba99 were the more tolerant and demonstrated high growth under salinity whereas Sham showed lowest growth under salinity.

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INTRODUCTION

Abiotic stresses reduce crop production by 50% which directly affects food security globally (Seleiman *et al.*, 2022). Plant growth and development are strongly affected by salinity stress, about 19.5% of irrigated lands and 2.1% of drylands are affected by salt stress that is expected to rise in the future (Dehnavi *et al.*, 2020). Every year, 1.5 million hectares of land are damaged by excessive salinity worldwide, and by the middle of the twenty-first century, 50% of arable land may be in poor condition (Dehnavi *et al.*, 2020; Kumari & Kaur, 2020). Mishandled irrigation, high evaporation rate and inadequate precipitation increased the size of saline areas in arid and semi-arid regions (Dai *et al.*, 2011; Jamil *et al.*, 2011). Environmental conditions lead to water stress in plants, for instance, saline habitats have high salt concentrations that lead to difficulties for roots to absorb water from the soil lead to a reduction in some morphological parameters such as vegetative growth and leaf area and physiological parameters such as photosynthesis and stomatal conductance reduction (Majeed, 2018; Saddiq *et al.*, 2021). Wheat *Triticum aestivum* is classified as the most important crop globally besides maize and rice which is significantly considered as a part of daily calories and protein and it ranked first for its values in domestication and staple food (Al-Hachami & Frhan, 2018; Iqbal *et al.*, 2021). Salinity stress deteriorates wheat development and growth resulting in grain, yield, and quality losses, Numerous processes, including physiological, biochemical, and molecular are used by plants to adjust to salinity at the level of the entire plant in order to maximize growth (Outoukarte *et al.*, 2019; EL Sabagh *et al.*, 2021). Drought has erupted due to climate change and global warming in the Middle East leading to a remarkable decrease in rainfall, snowfall and shortages in water resources. In Iraq, climate change is a major concern that negatively affects water resources and the economy, especially in the agricultural sector (Giovanis & Ozdamar, 2021). A field study conducted by Mohammed and Hassan (2022) showed a decrease in precipitation and an increase in temperatures that directly affect water source availability in southern Iraq. The study aimed to evaluate the seed germination and early growth of six Iraqi Wheat varieties under salinity stress in light of the water shortages and drought in Iraq and examine the variety's tolerance to salinity.

MATERIALS AND METHODS

Experimental Design

Six wheat seed varieties obtained from the Department of Plant-Tikrit University/College of Agriculture, the varieties (Iba99, Hadbaa, Hashmiaa, Al-Rasheed, Sham, and Rabiaa) were planted in the field under direct sunlight and normal weather conditions in triplicate and the Peat moss soil was used. The planting date was during the spring season and lasted for eight weeks from the date of planting to the date of measurements. The seeds were treated with four different NaCl concentrations (50, 100, 150, and 200 mM). The seed germination was observed during the first two weeks and recorded.

Germination Assessment

The seed germination of six wheat varieties was assessed by observing the germination status of the four treatments and the germination percentage GP was calculated according to the below equation:

$$GP = (\text{No. of normally germinated seeds} \div \text{total No. of seeds sown}) \times 100$$

Growth Assessment

The growth assessment of six wheat varieties was evaluated by measuring shoot length (SL), fresh weight (FW) and dry weight (DW). These measures were reported after 8 weeks of sowing after exposing the treatments to different NaCl using measuring tape and the results were recorded in tables.

RESULTS

Germination Results

The germination results of the six varieties shown in Table 1, three varieties (Ibaa99, Sham and Rabiaa varieties) were not affected by all the different salinity concentrations and showed germination in all treatments, it was 100% germination that appeared more tolerant to salinity stress. The other three wheat varieties were affected differently by the NaCl treatment where the germination of Hadbaa was 40%, Al-Rasheed 60% and Hashmiaa 80% germination. Hadbaa, Al-Rasheed and Hashmiaa are the most salinity-sensitive genotypes that are affected differently whereas the Hashmiaa genotype is the most sensitive to salinity stress that showed no germination at the levels (100, 150, and 200 mM). The NaCl concentration at 50 mM showed no effect at the germination level and the other concentrations 100, 150 and 200 mM were affected differently. The germination inhibition increased with the salinity concentration increase except for three varieties (Iba99, Sham and Rabiaa) that were not affected by the salinity concentration increase.

Growth Results

Shoot length

The Wheat shoot lengths that were measured in unit cm, it is clarified in Table 2. The results demonstrated that the Rabiaa genotype was the highest in shoot length followed by Hashmiaa, Iba99, Hadbaa, Al-rasheed and Sham respectively. The shoot lengths decreased with the NaCl increase as shown in the table. Rabiaa genotype was the highest in shoot length measures and Sham was the lowest in shoot length measures.

Fresh weight and dry weight

Evaluation of fresh and dry weight of Wheat samples measured using a sensitive scale at the laboratory in the unit gm. As shown in Table 3 the salinity significantly affected the fresh and dry weight due to its effect on water content level. The Rabiaa genotype had the highest weight followed by the Hashmiaa, Ibaa, Hadbaa, Al-rasheed then Sham genotypes. The salinity concentration affected the fresh-dry weight percentage as the salinity slightly decreased the fresh and dry weight measures. It was inversely proportional to the salinity concentration where the measures were recorded highly at 50 mM and the lowest measures were recorded at 200 mM of NaCl. Figure 1 visualizes the growth of the wheat varieties under salinity stress.

DISCUSSION

This study aimed to evaluate the salinity stress tolerance of six Iraqi Wheat varieties under different NaCl concentrations at germination and early seedling growth. Salinity stress can affect plant germination and growth differently depending on the species and genotype of the plant (Feghhenabi *et al.*, 2020; Mahmud *et al.*, 2022). The literature indicated that the features of germination and seedling are considered as the most viable indicators for plant final performance, we included early stages of plant development to study the mechanism of salinity tolerance

Table 1: Seed Germination percentage

Variety \ Salinity	Control	50 mM	100 mM	150 mM	200 mM	Germination%
Iba99	3	3	3	3	3	100
Hadbaa	3	3	0	0	0	40
Hashmiaa	3	3	3	3	0	80
Al-Rasheed	3	3	3	0	0	60
Sham	3	3	3	3	3	100
Rabiaa	3	3	3	3	3	100

Table 2: Shoot length results

Genotype \ Salinity	Control	50 mM	100mM	150mM	200mM
Iba99	39.12	28.51	28.15	28.22	22.11
Hadbaa	41.41	29.01	-	-	-
Hashmiaa	45.64	29.31	28.29	20.92	-
Al-Rasheed	32.52	23.19	19.22	-	-
Sham	19.98	16.79	16.39	14.22	13.67
Rabiaa	60.01	39.12	39.31	36.37	30.70

Table 3: Fresh and Dry Weight of Wheat varieties sample

Cultivar	Control		50mM		100mM		150mM		200mM	
	FW	DW	FW	DW	FW	DW	FW	DW	FW	DW
Iba99	2.437	0.709	1.531	0.674	1.201	0.541	1.022	0.502	1.089	0.412
Hadbaa	2.322	0.781	1.421	0.611	-	-	-	-	-	-
Hashmiaa	2.661	0.789	1.244	0.591	1.211	0.514	1.117	0.501	-	-
Al-Rasheed	2.531	0.722	1.036	0.563	1.229	0.503	-	-	-	-
Sham	1.971	0.583	0.812	0.423	0.789	0.409	0.708	0.378	0.793	0.351
Rabiaa	3.105	0.998	1.191	0.861	1.022	0.585	1.119	0.543	1.032	0.510

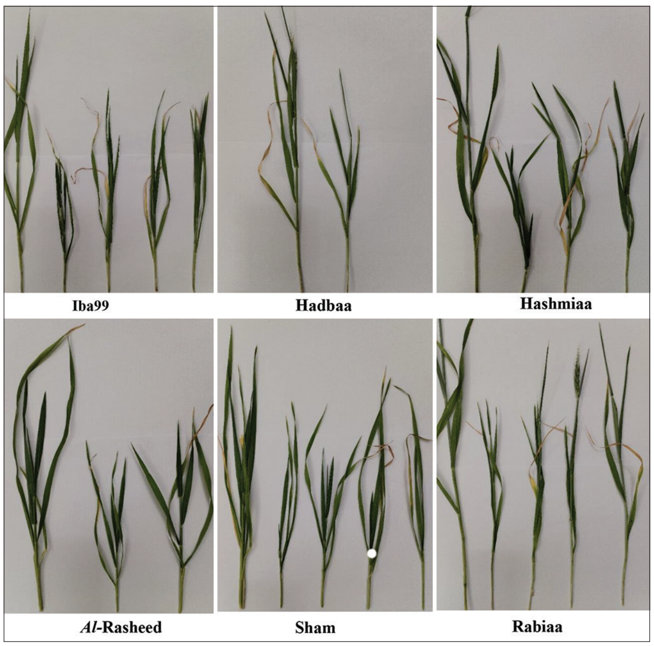

Figure 1: Photograph of the six wheat varieties

in different wheat varieties (Naik & Karadge, 2017; Smolikova *et al.*, 2020). Based on the results obtained, wheat genotypes differ in their response to salinity stress that is evaluated in the germination and seedling features. Our results showed that an increase in NaCl concentration the germination percentage GP affected in some wheat genotypes, with NaCl low concentration breaking seed dormancy and high concentrations of NaCl inhibits seed germination due to high osmotic potential effects and ion toxicity (Alkifaei & Al-Tahir, 2018; Soni *et al.*, 2021). Basically, several internal features of the seeds, such as age, seed coat properties, polymorphism, and seedling vigor might affect the germination of seeds under saline conditions, in addition to external elements such as light, water, temperature, and gasses (Wahid *et al.*, 2016; Naik & Karadge, 2017). Due to the low osmotic potential in the germination media, which decreases water absorption and inhibits seed germination, the germination process can be affected by changing the amount of water that seeds take in. (Zhu *et al.*, 2019). Accumulation of high levels of Na ions in the soil causes water absorption reduction due to the osmotic and drought stress (Bakhshandeh *et al.*, 2022). High salinity concentrations can cause enzymatic activity changes in plants and alter nucleic acids and protein metabolism (Ashraf *et al.*, 2018). In the current study, Hadbaa and Al-Rasheed genotypes had the lowest seed germination percentage when compared to non-stressed samples. Genotypes that maintain high germination and biomass yield are considered as salinity tolerant genotypes and the genotypes Hadbaa and Al-Rasheed are considered salinity-sensitive genotypes as reported by some studies (Zeeshan *et al.*, 2020; Pour-Aboughadareh *et al.*, 2021). Based on the obtained results concerning SL, FW and DW, all measures assessed showed a decrease with the NaCl increase in all genotypes and the degree of the reduction depends on the genotype. Root length and shoot length are the foremost influenced parameters due to the coordinate contact with saline arrangement within the root, and the shoot is straightforwardly influenced as the water supply is diminished (Asaadi, 2009). Saltiness adversely influences the ultrastructure of cells, tissues and organs (Koyro, 2002; Abari *et al.*, 2011). It was detailed that saltiness harmfulness and osmotic impacts restrain the essential upkeep for supplement accessibility levels that are fundamental for plant development and improvement and eventually restrain root and shoot development (Rasheed, 2009). The diminish in FW and DW of wheat tests is due to the toxic impact of Na on the photosynthesis rate. High levels of Na can lead to the low transport efficiency of essential ions such as NO_3 which reduce N-containing compounds and finally inhibit the growth and biomass of plants. Salinity stress can reduce the photosynthesis rate by stomatal closure led to CO_2 concentration reduction in the plant (Jamil *et al.*, 2006).

CONCLUSION

The study revealed that Iraqi wheat varieties are affected differently by salinity stress at the germination level and early growth stages. The germination and growth are affected inversely with the salinity increase. Rabiaa variety was the most tolerant and showed the highest growth while Sham variety showed the lowest and most sensitivity to salinity stress and other varieties were affected differently. Hadbaa, Al-Rasheed and Hashmiaa respectively were the most sensitive to salinity at the germination stage.

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