Research Article

Influence of salinity on germination and early seedling of five wheat (Triticum aestivum L) genotypes

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Abstract
Salinity is one of the most significant ecological stresses that deteriorate soil health, plant growth and development. It reduces germination and delays emergence of wheat. Under saline condition wheat stands irregular and depressed crop yield. In order to enhance wheat crop production under saline stress, it is essential to better understand genotypic variance and screening of high yielding and salt tolerant wheat genotypes. The main aim of this research work was to determine the influence of three salinity treatments viz. Control, 5-dSm⁻¹ and 10-dSm⁻¹on available five commercial wheat cultivars such as Sindh-81, Jauhar-78, Sarsabz, T.J-83 and Z.A. 77 under in-vitro condition. Seeds of five commercial wheat cultivars were then incubated in dark for 24hr, 48hr, 72hr and 96 hr at 22°C. The studied parameters including germination%, root and shoot length, root and shoot dry weight were also investigated. Germination was scored after ten days of seed placement. Completely randomized design with four replications was used. The obtained result showed that the germination, length of shoot and root were increased with an increase of incubation period, while decreased in response to increasing salinity level. Overall, the variety Sarsabz showed better adaptation, followed by T.J-83, Sindh-81, Jauhar-78 and Z.A. 77 for incubation period and salinity level. Therefore, it is suggested that the Sarsabz wheat cultivar can be successfully grown under ex-situ saline condition.

Keywords: Salinity; Germination; Seedling; Wheat cultivars

Introduction
Increasing population and changing environmental conditions are of significant concerns of world food security globally. Wheat is principal source of food and major cereal crop of Pakistan [1]. Thewheat grain is esteemed as an excellent food and high quality protein. Furthermore, its kernel contains approximately 60-68% starch, 8-15% protein, 2-2.5% cellulose, 1.5-2% fat, 2-3% sugar and 1.5-2% mineral matter. Current improvement rate of important crops is...
inadequate to meet future requirement. Wheat production widely fluctuated due to interaction with environmental conditions. Furthermore, it is well known as moderately tolerant to saline condition. Grain yield in bread wheat is polygenic hereditary character, affected by several factors directly or indirectly [2]. Soil salinity, alkalinity and water logging damage to germinating seed and to established crop plant [3, 4]. The main root cause of the high salinity problem in the soil are the widespread application of chemical fertilizers, untreated waste water irrigation and the high amount of evapotranspiration in summer [5, 6]. Shrivastava et al. [7] revealed that nearly 20% of all farm lands around the globe comprising augmented levels of soluble and insoluble salts. Since that the germination process is not likely without water, the foremost adverse impact of salt in soils is reflected in producing osmotic possibilities that will avoid the seeds and seedling from absorbing an adequate quantity of water. Likewise, in salty situations, seeds and seedlings absorb the high quantities of Na+ and Cl− molecules, which exert their poisonous influences in plant cells [8]. In such soil condition seed and seedling tolerance to salinity becomes critical factor to success establishment of crop. Soil salinity may affect germination of seed in two ways, by decrease of water and entry of toxic ions. Soil salinity is directly proportional to NaCl concentration [9]. Therefore, evaluation of seed and seedling in-vitro is necessary, prior to sowing in the field. In the former study, Izadi et al. [10] investigated the impact of salinity stress on physiological parameters of different wheat and barley genotypes. Also, Iqbal et al. [11] examined the impact of salinity on wheat characteristics. Recently, Ibarra-Villarreal et al. [12] revealed that the potential of salt-tolerant Bacillus species as a promising approach to alleviate the negative impacts of saline soils on wheat. Also, Ding et al. [13] found that the vermin-compost as amendment and deep tillage system significantly increase saline-sodic soil quality and wheat yield. However, limited information is available with spiked different levels of salinity on the physiological parameters of five commercial cultivars such as Sindh-81, Jauhar-78, Sarsabz, T.J-83 and Z.A. 77 under in-vitro condition. Hence, the main aim of this work was to investigate the influence of two salinity levels on the germination and early seedling growth of five wheat cultivars under in-vitro condition.

**Materials and Methods**

This experiment was conducted at laboratory of Shaheed Z. A. Bhutto Agricultural College Dokri. Varieties selected for this experiment were Sindh-81, Jauhar-78, Sarsabz, T.J.-83 and Z.A. 77. Three treatments viz. Control, 5-dSm−1 and 10-dSm−1. In order to inhibit microbial contamination during germination, dry grains were sterilized in dilute sodium hypochlorite solution (15%). Dry grains were put into flasks containing 50ml of 15% Sodium hypochlorite for sterilization, a period of about 15 minute. Seeds washed with several time by distilled water. Grains were placed as crease down on a double layer of Whatman-540 paper moistened with 7ml of sterilized distilled water in petridishes. Seeds were then incubated in dark for 24hr, 48hr, 72hr and 96 hr at 22°C. Following observations were recorded: 1) Germination (%); 2) Length of shoot (cm), and 3) Length of root (cm).

**Results and Discussion**

**Germination:** Data regarded germination of seeds under optimal condition (Control) and under stress of salinity presented in(Table 1). In control, germination % of seeds of all the cultivar increased with increase of incubation period. Sarsabz and T.J-83 exhibited more germination value as compare to other cultivar at 72 hours of incubation and germination of seeds of all cultivar noted between 98-100 %, suggested that seeds were
almost hundred % viable. Clear effect of salinity on germination of seed was observed in all cultivars at various salinity doses. At EC 5d Sm⁻¹ (T₁), reduction of 3-5.5, 4.2-6.2, 5.2-15.8 and 7.1-12.1% over the control was observed at incubation periods of 24, 48, 72 and 96 hours respectively. Germination of seed was further reduced in response to increased level of salinity. All cultivar decreased of 11.2-15.1, 15-20, 18.5-26.5 and 9 - 25% over control when salinity was raised to EC 10dSm⁻¹ (T₃) and Sarsabz and TJ-83 gave better performance under this salinity stress. The difference between cultivars was highly significant. Interaction between 3 factor viz; variety, salinity level and incubation period were highly significant. Results were close agreement with Mehta and Desai [9], they reported significant decreased germination with an increased level of salinity, and furthermore the suppressive action of salts on germination was due to their metabolite effect and not on the osmotic action.

**Table 1. Effect of salinity on germination (%) (Mean of replications)**

| Varieties | Incubation hours (I) | EC (d Sm⁻¹) | Interaction (V x I xT) |
|-----------|----------------------|-------------|------------------------|
|           | 24                   | 48          | 72                     | 966                    |
|           | 0  5 10 0 5 10 0 5 10 0 5 10 0 5 10 0 5 10 |
| Sindh-81  | 85 81 74 0   88 79 96 90 78 98 91 77 |
| Jauhar-78 | 86 83 75 90 85 76 95 80 70 99 87 74 |
| Sarsabz   | 89 86 79 96 90 78 98 91 80 100 94 91 |
| TJ-83     | 90 85 78 95 91 76 96 91 81 98 91 76 |
| Z.A.77    | 86 82 73 92 87 78 94 87 75 99 90 75 |

**Shoot length**

Data regarding shoot length depicted in (Table 2), showed that under Local control condition (T₁), average shoot length of various cultivar ranged from 0.2 - 0.25, 1.3 - 1.44, 2.3 - 2.54, 4.28 - 4.48cm at incubation period of 24, 48, 72 and 96 hours respectively. At EC 5dSm⁻¹ (T₂), reduction in shoot length was between 8 - 17.4, 3.8 - 9, 8.6 – 14.6 and 4 - 21.1% at incubation period of 24, 48, 72 and 96 hours respectively. These values decreased further to 19 - 24, 10.7 - 16.6, 28.4 - 29.5 and 30.1 - 56.3% at 24, 48, 72 and 96 hours of incubation respectively, when salinity was raised to EC 10dSm⁻¹ (T₃). Sarsabz was more salt tolerant in terms of shoot length, followed by TJ-83, Sindh-81, Jauhar-78 and Z.A.77 respectively. Difference between cultivar was highly significant at all incubation period. Interaction between various factor i.e. cultivar; incubation period and salinity level were also highly significant. Decreased shoot length observed in present study could be due to lethal effect of chloride on plumule at time of emergence of seedling. These result confirm finding of Hanna et al.[14]; Singh et al. [15], they reported that increased level of salinity potentially decreased coleoptile length and seedling growth and reduction in coleoptile growth was due to inhibition of cell elongation rather than cell multiplication.
Table 2. Effect of salinity on shoot length (cms) (mean values from replications)

| Varieties | Incubation hours (I) | EC (d Sm⁻¹) |
|-----------|----------------------|-------------|
|           | 24  | 48  | 72  | 966 |
| Sindh-81  | 0.2 | 0.18| 0.16| 1.3 | 1.25| 1.16|
| Jauhar-78 | 0.21| 0.18| 0.16| 1.32| 1.23| 1.17|
| Sarsabz   | 0.25| 0.23| 0.19| 1.44| 1.31| 1.2 |
| T.J-83    | 0.21| 0.19| 0.17| 1.36| 1.27| 1.17|
| Z.A.77    | 0.23| 0.19| 0.18| 1.3  | 1.22| 1.13 |

**Root length**

Data regarding effect of salinity on root length presented in (Table 3). Length of root of all cultivar was varied between 0.17 - 0.23, 1.43 - 1.66, 2.9 -3.42 and 4.71 - 5.86 cm at 24, 48, 72 and 96 hours of incubation respectively against Control (T₁). These values decreased in response to salinity. Overall reduction of 10.5 - 17.6, 5.4 - 6.3, 8.6 - 9.8 and 7.9 -10.4% in root length over control was observed at incubation period of 24, 48, 72 and 96 hours respectively, at salinity level EC 5dSm⁻¹ (T₂). Reduction of 21 - 29.4, 11.6 - 15.3, 21 - 23.9 and 20.2 - 27.6% in root length over control (T₁) observed in response to salinity at EC 10dSm⁻¹ (T₃) in incubation period of 24, 48, 72 and 96 hours respectively. Performance of Sarsabz was found to be better under both control and salinity stress as compared with other cultivars. Maximum root length was recorded in Sarsabz followed by T.J-83, Sindh-81 and Jauhar-78 respectively. Cultivar Z.A.77 produced smaller roots as compared to other cultivar. Varietal difference was highly significant. Incubation period and salinity level were also highly significant. Furthermore, interaction between these factors was also found to be significant. Result of this experiment are supported by [1,16,17], who reported higher level of salinity decreased root weight significantly. They described that salinity had more adverse effect on coleoptiles length and weight as compared root. Saqib et al. [18] revealed a negative significant correlation among salt tolerance and Na⁺ content in the shoot by wheat genotypes. Sairam et al. [19] found that tolerant and quite tolerant wheat varieties differentially augmented proline in salt stress. Liu et al.[20] observed that salinity stress resulted in the decreased plant vigor. This reduce in plant strength might be due to the decline in osmotic potential or ions toxicity of salts [21].

**Table 2. Effect of salinity on shoot length (cms) (mean values from replications)**

| Varieties | Incubation (I) | Treatments (T) | Interaction | (V x I xT) |
|-----------|----------------|----------------|-------------|-------------|
|           | S.E mean       | 0.0067         | 0.0248      | 0.0052      | 0.0231      |
| Cd₁       | 0.0189         | 0.0168         | 0.0146      | 0.0647      |
| Cd₂       | 0.0248         | 0.0222         | 0.0193      | 0.0856      |
| Remarks   | **             | **             | **          | **          |
Table 3. Effect of salinity on root length (cms) (mean values from replications)

| Varieties | Incubation hours (I) | EC (d Sm⁻¹) |
|-----------|----------------------|-------------|
|           | 24                   | 48          | 72          | 966         |
|           | 0 5 10               | 0 5 10      | 0 5 10      | 0 5 10      |
| Sindh-81  | 0.19 0.17 0.15       | 1.53 1.44 1.35 | 3.12 2.82 2.4 | 4.96 4.54 3.91 |
| Jauhar-78 | 0.18 0.15 0.13       | 1.47 1.38 1.27 | 3.05 2.75 2.32 | 4.87 4.46 3.87 |
| Sarsabz   | 0.23 0.19 0.17       | 1.66 1.57 1.46 | 3.42 3.11 2.7  | 5.86 5.25 4.24 |
| T.J-83    | 0.21 0.18 0.16       | 1.59 1.50 1.39 | 3.23 2.94 2.51 | 5.14 4.73 4.1 |
| Z.A.77    | 0.17 0.14 0.12       | 1.43 1.34 1.21 | 2.9 2.65 2.23 | 4.71 4.32 3.7 |

Varieties (V) | Incubation (I) | Treatments (T) | Interaction | (V x I x T)
S.E mean | 0.0026 | 0.0023 | 0.002 | 0.009
Cd₁ | 0.0073 | 0.0064 | 0.0056 | 0.0252
Cd₂ | 0.0096 | 0.0085 | 0.0074 | 0.0333

Remarks | ** | ** | ** | *

Conclusion
From this experiment it was concluded that before cultivation of wheat on saline soils, it is necessary to test its germination% which must not less than 85%. Wheat cultivar Sarsabz and TJ-83 are preferred to cultivate for high yield both in dry lands and irrigated conditions. Overall, it is suggested that the future research work should be conducted in detailed and tested free-proline, soluble sugars, starch, phytohormone concentrations, antioxidase activity and transcription of related genes of five studied wheat cultivars under saline condition.

Authors’ contributions
Conceived and designed the experiments: NA Panhwar, Performed the experiments: SA Panhwar, Analyzed the data: NA Panhwar, Contributed materials/ analysis/tools: SA Burijo & AH Memon, Wrote the paper: NA Panhwar & AH Lahori.

References
1. Amanullah, Lakhan GR, Channa SA, Magsi H, Koondher MA, Wang J & Channa NA (2020). Credit constraints and rural farmers’ welfare in an agrarian economy. Heliyon 6: e05252.
2. Kumar J, Singh SK, Singh L, Kumar A, Anurag Singh SK & Kumar M (2016). Estimates of general and specific combining ability for grain yield and other physiological characters in bread wheat under late sown condition. Res Environ Life Sci 9(7): 784-789.
3. Zahedi SM, Nabipour M, Azizi M, Gheisary H, Jalali M & Amini Z (2011). Effect of kinds of salt and its different levels on seed germination and growth of basil plant. World Appl Sci J 15(7): 1039-1045.
4. Chaurasia S, Singh AK, Songachan LS, Sharma AD, Bhardwai R & Singh K (2020). Multi -locus genome-wide association studies reveal novel genomic regions associated with vegetative stage salt tolerance in bread wheat (Triticum aestivum L.). Genomics 112(6): 4608-4621.
5. Sarmugam R & Worsley A (2014). Current Levels of Salt Knowledge: A Review of the Literature. Nutrients 6: 5534–5559.
6. Shila A, Haque MA, Ahmed R & Howlader MHK (2016). Effect of different levels of salinity on germination and early seedling growth of sunflower. World Res J Agri Sci 3(1): 048-053.
7. Shrivastava P & Kumar R (2015). Soil salinity: A serious environmental issue and plant growth promoting bacteria as
one of the tools for its alleviation. *Saudi J Biol Sci* 22(2): 123-131.

8. Khajeh-Hosseini M, Powell AA & Bingham IJ (2003). The Interaction Between Salinity Stress and Seed Vigor During Germination of Soybean Seeds. *Seed Sci Technol* 31: 715-725.

9. Mehta BV & Desai RS (1985). Effect of soil salinity on germination of some seeds. *J Soil Waterconserv India* 168-176.

10. Izadi MH, Rabbani J, Emam Y, Pessarakli M & Tahmasebi A (2014). Effects of salinity stress on physiological performance of various wheat and barley cultivars. *J Plant Nut 37*(4): 520-531.

11. Iqbal M, Irshad S, Nadeem M, Fatima T & Irat AB (2018). Salinity effects on wheat (*Triticum aestivum* L.) characteristics. *Int J Biosci* 12(3): 131-146.

12. Ibarra-Villarreal AL, G´andara-Ledezma A, Dafne Godoy- Ledezma A, María Díaz-Rodríguez A, Isela Parra-Cota F & Santos-Villalobos SDL (2021). Salt-tolerant Bacillus species as a promising strategy to mitigate the salinity stress in wheat (*Triticum turgidum* subsp. *durum*). *J Arid Environ* 186: 104399.

13. Ding ZL, Kheir AMS, Ali OAM, Hafez EM, ElShamey EA, Zhou ZX, Wang BZ, Lin XG, Ge Y, Fahmy AE & Seleiman MF (2021). A vermicompost and deep tillage system to improve saline-sodic soil quality and wheat productivity. *J Environ Manage* 277: 111388.

14. Hann LPH, Zaitoon MI & Hussain M (1978). Effect of different levels of NaCl on growth andmineral composition of some wheat varieties. *In Soil and Fertilizers* 43(2): 146.

15. Singh G, Kaur P, Kaur M & Sharma R (1985). Effect of CCC and Kinetin on seed germination and early seedling growth in wheat under saline conditions. *Indian J Pl Physiol* 28(4): 310-317.

16. Khanzada AN, Naqvi SSM & Ansari R (1984). Proline content in relation to the salt tolerance in wheat. Proc. of Symp. on environmental stress and plant growth pp. 9-18.

17. Chaurasia S, Singh AK, Songachan LS, Sharma AD, Bhardwaj R & Singh K (2020). Multi-locus genome-wide association studies reveal novel genomic regions associated with vegetative stage salt tolerance in bread wheat (*Triticum aestivum* L.). *Genomics* 112(6): 4608-4621.

18. Saqib M, Zorb C & Schubert S (2006). Salt-resistant and salt-sensitive wheat genotypes show similar biochemical reaction at protein level in the first phase of salt stress. *J Plant Nutr Soil Sci* 169(4): 542–548.

19. Sairam RK, Rao KV & Srivastava GC (2002). Differential response of wheat genotypes to long term salinity stress in relation to oxidative stress, antioxidant activity and osmolytes concentration. *Plant Sci* 163(5): 1037–1046.

20. Liu S, Guo X, Feng G, Maimaitiaili B, Fan J & He X (2015). Indigenous arbuscular mycorrhizal fungi can alleviate salt stress and promote growth of cotton and maize in saline fields. *Plant Soil* 398: 195-206.

21. Farooq M, Hussain M, Wakeel A & Siddique KHM (2015). Salt stress in maize: effects, resistance mechanisms, and management. A review. *Agron Sustain Dev* 35: 461-481.