

Research Article

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

Nazeer Ali Panhwar^{1*}, Saeed Ahmed Buriro², Abdul Hameed Memon³, Sajjad Ali Panhwar⁴ and Altaf Hussain Lahori⁵

1. Department of Plant Breeding and Genetics, Shaheed Z. A. Bhutto Agricultural College Dokri-Pakistan

2. Department of Horticulture, ShaheedZ.A.Bhutto Agricultural College Dokri-Pakistan

3. Department of Soil Science, Shaheed Z. A. Bhutto Agricultural College Dokri-Pakistan

4. Department of Crop Genetics and Breeding Hainan University Haikou City-China

5. Department of Environmental Sciences, Sindh Madressatul Islam University, Karachi, 74000-Pakistan

*Corresponding author's email: nazir_ipanhwar@yahoo.com

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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⁻¹ on 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]. The wheat 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)											
	24			48			72			966		
	EC (d Sm ⁻¹)											
	0	5	10	0	5	10	0	5	10	0	5	10
Sindh-81	85	81	74	93	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
T.J-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
Varieties (V)	Incubation (I)			Treatments (T)			Interaction			(V x I x T)		
S.E mean	0.2775			0.2482			0.2150			0.9615		
Cd ₁	0.7770			0.6950			0.6020			2.6923		
Cd ₂	1.0282			0.9196			0.7966			3.5626		
Remarks	**			**			**			**		

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 plumole 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)											
	24			48			72			966		
	EC (d Sm ⁻¹)											
	0	5	10	0	5	10	0	5	10	0	5	10
Sindh-81	0.2	0.18	0.16	1.3	1.25	1.16	2.4	2.09	1.7	4.43	3.91	2.02
Jauhar-78	0.21	0.18	0.16	1.32	1.23	1.17	2.36	2.04	1.68	4.35	3.83	1.95
Sarsabz	0.25	0.23	0.19	1.44	1.31	1.2	2.54	2.24	1.82	4.48	4.3	3.13
T.J-83	0.21	0.19	0.17	1.36	1.27	1.17	2.46	2.1	1.76	4.46	3.97	2.07
Z.A.77	0.23	0.19	0.18	1.3	1.22	1.13	2.3	2.1	1.62	4.28	3.76	1.87
Varieties (V)	Incubation (I)			Treatments (T)			Interaction			(V x I x T)		
S.E mean	0.0067			0.0248			0.0052			0.0231		
Cd ₁	0.0189			0.0168			0.0146			0.0647		
Cd ₂	0.0248			0.0222			0.0193			0.0856		
Remarks	**			**			**			**		

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 TJ-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 3. Effect of salinity on root length (cms) (mean values from replications)

Varieties	Incubation hours (I)											
	24			48			72			966		
	EC (d Sm ⁻¹)											
	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		
Cd ₁	0.0073			0.0064			0.0056			0.0252		
Cd ₂	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 Buriro & AH Memon, Wrote the paper: NA Panhwar & AH Lahori.

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