International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 10, No. 4, p. 275-283, 2017

RESEARCH PAPER OPEN ACCESS

Screening of wheat (*Triticum aestivum* L.) genotypes for salinity tolerance at seedling stage

Zubair Sajid[1], Shoaib Liaqat*[2], Wajiha Anum[3], Ali Ammar[3], Natasha Kanwal[3], Akash Zafar[3], Rana Azeem Ahmad[4], Gahayour Ahmed[5], Abdul Karim[5]

[1]*Department of Plant Breeding and Genetics, Bahauddin Zakariya University, Multan, Pakistan*

[2]*Vegetable Research sub-station, Bahawalpur, Pakistan*

[3]*Regional Agricultural Research Institute, Bahawalpur, Pakistan*

[4]*Deputy District Office, Agriculture Extension, Shujabad, Pakistan*

[5]*Cotton Research Station, Multan, Pakistan*

Key words: Wheat, Seedling, Salinity, Variation

http://dx.doi.org/10.12692/ijb/10.4.275-283 Article published on April 30, 2017

Abstract

Establishment of seedlings at early growth stages of crop plants as one of the most important determinants of high yield is severely affected by soil salinity. Evolution of salt tolerance genotypes is one of the major techniques to overcome this problem. Therefore, present investigation was under taken to screen out twelve (12) wheat genotypes at seedling stage under four level of salt stress 150, 250,350 mMNaCl including one control condition. Salinity treatments (150, 250 and 350) were achieved by adding NaCl in deionized water. All the wheat genotypes were moderately susceptible except the approved varieties (Sehar-06, Fareed-06 and Miraj-08) which were tolerant to different salinity levels. It is evident from the findings that salinity could decrease chlorophyll contents, root length, shoot length, root fresh weight, root dry weight, shoot fresh weight and shoot dry weight of wheat genotypes. Also, at low concentration of salt, all the genotypes gave better performance (<200 mMNaCl solution) and can best grow at low salty areas although approved varieties can be used in next breeding program because they are highly tolerant to salinity.

* **Corresponding Author:** Shoaib Liaqat ✉ shoaib87pk@hotmail.com

Introduction

Wheat is the staple food of Pakistan and positioned at second worldwide with respect to yield after maize (Zeb *et al.*, 2009). In order to meet the demands of increasing population, the predicted requirement of wheat varies from 840 million tons (Rosegrant *et al.*, 1995) to 1050 million tons (Kronstad, 1998) for the year 2020. However, due to increasing salinity and growing population, there is still a need to increase wheat production in the country. Literature available on salt tolerance in wheat varieties suggests that it is a moderately salt tolerant crop with a threshold level of 6-7 dS m -1 (Maas, 1986).

The possible cause of varietal difference most likely evolves ion transport properties and cellular compartementation (Torech *et al.*, 1993). Schacht Mann and Munns (1992) reported that sodium exclusion was a general characteristic of salt tolerance in wheat lines; whereas, salt tolerant display much higher shoot sodium level than sensitive lines. Salinity causes considerable reduction in crop production (Rengasamy, 2006; Katerji *et al.*, 2009). In most areas of Pakistan irrigated water has high sodium absorption ratio which deteriorate the soils structure and too little water infiltration leads to water logging and salinization (Qureshi and Barrett-Lennard, 1998). Identification of plant mechanisms for salt tolerance and breeding new cultivars are the best strategies for reducing salinity effects in agriculture (Forster *et al.*, 1987; Yamaguchi and Blumwald, 2005). Salt stress affects germination percentage, germination rate and seedling growth in different ways depending on plant species (Ungar, 1996; Gul *et al.,* 1999. To plan efficient breeding programs for developing salt tolerant varieties, information on the genetic basis of salt tolerance, mode of inheritance, magnitude of gene effects and their mode of action are necessary. Na+ concentration in shoots and K+/Na+ discrimination are used to study salt tolerance in bread wheat (Munns and James, 2003; Munns *et al.*, 2006). In order to grow wheat in saline environments, plants have adapted a number of morphological, physiological and biochemical processes to mitigate the effects of high concentrations of toxic salts and accordingly vary in their ability to tolerate saline conditions. Physiological traits such as potassium selectivity, exclusion and/or compartmentation of sodium and chloride ions, osmotic adjustment by accumulation of organic solutes (proline, glycine-betaine, total sugars) have all been related to salt tolerance of crop plants (Wyn Jones &Storey 1981). The study presented here deals with the response of twelve genotypes of wheat to NaCl stress at early growth stage.

Therefore the aims of the present study were:

i) To assess the impact of salt stress on different varieties of wheat

ii) To screen out best salinity resistant wheat genotype

iii) To assess the various morphological changes associated with the plants under different salinity levels.

Material and method

Three seeds of twelve wheat genotypes (Table 1.) were planted in plastic bags filled with 0.5kg of soil. The pH, EC and saturation % age of soil medium was determined which were 7.9, 0.79 and 26.2 respectively. Twelve genotypes tested under different salinity levels were randomized under three replications following two-factor factorial Completely Randomized Design (CRD).

T_1= control (distilled water),

T_2=150 mM of salt (NaCl)

T_3=250 mM of salt (NaCl)

T_4=350 mM of salt (NaCl)

Table 1. Names of Wheat genotypes used in the experiment.

Code	Genotype	Code	Genotype
V_1	Miraj-08	V_7	99199
V_2	88131	V_8	88146
V_3	99192	V_9	88148
V_4	88106	V_{10}	6317
V_5	88124	V_{11}	76346
V_6	Fareed-06	V_{12}	Sehar-06

The seeds of each genotype were given proper moisture in the growing medium.

The desired level of salinity i.e., 150mM, 250mm and 350mM were completed in four steps i.e., first dose of different salinity levels were applied after 7 days of germination (at 2nd leaf stage). The second dose of different levels of salinity was applied after 4 days of 1st application. Thereafter water containing 150, 250 and 350mM of NaCl was applied to growing seedlings after 4 days of 2nd treatment and last the fourth dose of different salinity levels was given at seedling stage after 4 days of 3rd application of salinity. After 22 days, the desired parameters i-e Chlorophyll contents, shoot length (cm), root length (cm), fresh shoot weight (g), dry shoot weight (g), fresh root weight (g) and dry root weight (g)under each treatment were taken. Chlorophyll contents were measured with Spectrophotometer following the method of Mckinney (1940) and the formula of Machlachalan and Zalik (1963).

Statistical Analysis

Collected data regarding all the parameters were analyzed by using Fisher's analysis of variance technique and means of treatments were separated by LSD test at 5% probability to establish difference between the genotypes, salinity levels and their interaction (Steel *et al.*, 1997).

Results

The data regarding variation in chlorophyll contents, shoot length, root length, fresh shoot weight, dry shoot weight, fresh root weight and dry root weight showed great significant difference among the groups. Results revealed that in case of chlorophyll contents, maximum reduction was noted in 99119, 88146 and 88148 however, genotypes Miraj-08 and Sehar-06 retained maximum chlorophyll contents with less than 20% reduction (Table 2.). All the genotypes showed a slight declining trend in chlorophyll contents with increase in salinity. Maximum root length was recorded on V_4 (88106) and V_{12} (Sehar-06) in T_0 treatment where no application of salt was done. All the varieties except V_{12} (Sehar-06) had statistically same root length. Minimum root length was observed where 350mM salt concentration was applied (Table 3.). V_4 (88106) expressed maximum shoot length where no application of NaCl was applied whereas maximum shoot length under NaCl was recorded in V_{12} (Sehar- 6). Minimum shoot length of wheat genotypes was recorded under high salinity levels in V_6 (Fareed-06), clearly indicates great difference among the wheat genotypes (Table 4.). Genotype V_{12} (Sehar-06) revealed maximum root fresh weight in normal as well as in saline conditions while Minimum was observed in V_5 (88124) and V_8 (88146) in normal as well as in high saline conditions (Table 5.). In case of root dry weight, maximum was recorded in V_2 (88131) and V_{12} (Sehar-06)while minimum in V_4 (88106) and V_{11} (76346) both in normal as well as in high saline environment (Table 6.). The root dry weight of cultivar V_{12} (Sehar-06) showed the lowest and genotype V_{11} (76346) showed the highest significant reduction in root weight among the cultivars tested compared to the unstressed plants where as remaining cultivars also showed a significant reduction in dry weight of root following the same trend. The highest shoot fresh weight was recorded in V_2 (88131) and V_{12} (Sehar-06) and lowest value of shoot fresh weight was recorded in V_{11} (76346) where maximum dose of salt (350mM of NaCl) was applied (Table 7.). The effect of interaction between salinity levels and varieties on shoot fresh weight was found non-significant. Genotypes V_9 (88148) and V_{12} (Sehar-06) showed maximum shoot dry weight whereas minimum shoot dry weight was observed in V_8 (88146) and V_{10} (6317) (Table 8.).

Table 2. Comparison of means for chlorophyll contents.

Variety	Treatments				Mean
	T_0	T_2	T_3	T_4	
V_1	38.54 ± 0.02	33.41 ± 0.83	26.17 ± 1.26	24.10 ± 1.25	30.56 ± 1.79 B
V_2	38.63 ± 0.39	33.03 ± 0.44	27.96 ± 0.36	21.98 ± 1.63	30.40 ± 1.89 BC
V_3	36.14 ± 0.41	32.68 ± 1.05	26.04 ± 1.31	21.18 ± 0.93	29.01 ± 1.80 B-E
V_4	36.80 ± 0.23	34.14 ± 0.45	28.83 ± 0.71	22.29 ± 2.03	30.52 ± 1.74 B
V_5	36.34 ± 0.71	31.21 ± 0.61	24.94 ± 0.39	22.26 ± 0.82	28.69 ± 1.68 DE

Variety	Treatments T_0	T_2	T_3	T_4	Mean
V_6	37.29 ± 0.57	33.71 ± 0.94	25.60 ± 0.43	20.87 ± 1.03	29.37 ± 1.98 B-E
V_7	34.88 ± 0.45	31.04 ± 0.32	25.82 ± 0.34	19.81 ± 0.98	27.89 ± 1.73 E
V_8	36.01 ± 0.77	33.28 ± 0.66	26.88 ± 2.28	20.49 ± 1.94	29.16 ± 1.93 B-E
V_9	37.39 ± 1.04	31.40 ± 0.80	26.54 ± 0.91	20.21 ± 0.69	28.89 ± 1.94 CDE
V_{10}	36.72 ± 1.13	30.42 ± 0.59	25.44 ± 0.34	20.72 ± 0.71	28.33 ± 1.82 DE
V_{11}	37.18 ± 1.33	32.29 ± 0.28	26.42 ± 1.13	22.02 ± 1.29	29.48 ± 1.79 BCD
V_{12}	40.31 ± 0.48	34.97 ± 0.60	29.39 ± 2.71	26.10 ± 3.16	32.69 ± 1.87 A
Mean	37.19 ± 0.29 A	32.63 ± 0.28 B	26.67 ± 0.38 C	21.84 ± 0.47 D	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

Table 3. Comparison of means for root length.

Variety	Treatment T_0	T_2	T_3	T_4	Mean
V_1	23.56 ± 0.67	21.16 ± 0.92	18.01 ± 0.36	14.42 ± 1.69	19.29 ± 1.12 B
V_2	24.62 ± 0.71	21.16 ± 0.60	18.83 ± 0.61	12.57 ± 0.35	19.29 ± 1.35 B
V_3	25.50 ± 0.48	21.63 ± 0.37	17.50 ± 1.55	14.83 ± 0.48	19.87 ± 1.28 B
V_4	25.98 ± 0.43	22.74 ± 0.23	19.01 ± 0.88	12.34 ± 0.60	20.02 ± 1.55 B
V_5	24.78 ± 0.49	22.36 ± 0.58	18.16 ± 0.53	13.86 ± 0.53	19.79 ± 1.28 B
V_6	23.98 ± 0.60	22.00 ± 0.67	18.80 ± 0.59	12.74 ± 0.09	19.38 ± 1.30 B
V_7	25.22 ± 0.95	22.17 ± 0.86	18.46 ± 0.99	13.41 ± 0.42	19.81 ± 1.38 B
V_8	25.18 ± 0.48	21.76 ± 0.12	17.71 ± 1.16	13.62 ± 0.23	19.57 ± 1.33 B
V_9	23.78 ± 0.50	21.41 ± 0.39	18.48 ± 0.95	13.31 ± 0.52	19.24 ± 1.21 B
V_{10}	23.37 ± 0.32	21.76 ± 0.72	18.24 ± 0.81	13.69 ± 0.42	19.26 ± 1.15 B
V_{11}	25.34 ± 0.56	21.82 ± 1.11	18.40 ± 0.62	13.54 ± 1.23	19.78 ± 1.37 B
V_{12}	26.82 ± 0.44	23.03 ± 0.87	20.70 ± 0.47	16.88 ± 0.54	21.86 ± 1.12 A
Mean	24.84 ± 0.22 A	21.92 ± 0.19 B	18.53 ± 0.24 C	13.77 ± 0.26 D	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

Table 4. Comparison of means for shoot length.

Variety	Treatment T_0	T_2	T_3	T_4	Mean
V_1	5.17 ± 0.27	4.32 ± 0.36	3.60 ± 0.40	2.28 ± 0.13	3.84 ± 0.35 AB
V_2	4.77 ± 0.19	3.96 ± 0.16	3.41 ± 0.11	2.48 ± 0.06	3.65 ± 0.26 BCD
V_3	4.86 ± 0.10	3.76 ± 0.11	3.31 ± 0.20	2.33 ± 0.21	3.56 ± 0.28 CD
V_4	5.39 ± 0.16	4.12 ± 0.06	3.32 ± 0.23	2.27 ± 0.12	3.78 ± 0.35 ABC
V_5	4.72 ± 0.09	3.99 ± 0.18	3.24 ± 0.10	2.33 ± 0.03	3.57 ± 0.27 CD
V_6	4.69 ± 0.16	3.83 ± 0.12	3.21 ± 0.16	2.16 ± 0.09	3.47 ± 0.28 D
V_7	4.68 ± 0.14	4.00 ± 0.09	3.41 ± 0.04	2.49 ± 0.07	3.64 ± 0.25 BCD
V_8	4.68 ± 0.02	3.99 ± 0.16	3.48 ± 0.10	2.28 ± 0.03	3.61 ± 0.27 CD
V_9	4.50 ± 0.05	3.80 ± 0.12	3.31 ± 0.15	2.23 ± 0.07	3.46 ± 0.25 D
V_{10}	4.71 ± 0.10	3.93 ± 0.15	3.38 ± 0.12	2.30 ± 0.05	3.58 ± 0.27 CD
V_{11}	4.88 ± 0.26	3.98 ± 0.07	3.31 ± 0.11	2.34 ± 0.06	3.63 ± 0.29 BCD
V_{12}	5.07 ± 0.09	4.17 ± 0.22	3.63 ± 0.23	2.97 ± 0.13	3.96 ± 0.24 A
Mean	4.84 ± 0.05 A	3.99 ± 0.05 B	3.39 ± 0.05 C	2.37 ± 0.04 D	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

Table 5. Comparison of means for root fresh weight.

Variety	Treatment T_0	T_2	T_3	T_4	Mean
V_1	0.267 ± 0.007	0.216 ± 0.006	0.149 ± 0.014	0.087 ± 0.018	0.179 ± 0.021 BC
V_2	0.247 ± 0.010	0.216 ± 0.005	0.154 ± 0.004	0.099 ± 0.007	0.179 ± 0.017 BCD
V_3	0.254 ± 0.006	0.198 ± 0.008	0.143 ± 0.013	0.091 ± 0.009	0.172 ± 0.019 CDE
V_4	0.253 ± 0.002	0.210 ± 0.007	0.167 ± 0.010	0.083 ± 0.003	0.178 ± 0.019 BCD

Variety	Treatment				Mean
	T_0	T_2	T_3	T_4	
V_5	0.241 ± 0.008	0.201 ± 0.003	0.142 ± 0.012	0.080 ± 0.007	0.166 ± 0.019 E
V_6	0.274 ± 0.007	0.204 ± 0.008	0.166 ± 0.009	0.091 ± 0.006	0.184 ± 0.020 B
V_7	0.261 ± 0.003	0.207 ± 0.003	0.146 ± 0.005	0.084 ± 0.003	0.174 ± 0.020 B-E
V_8	0.229 ± 0.003	0.204 ± 0.007	0.152 ± 0.011	0.080 ± 0.002	0.166 ± 0.017 E
V_9	0.244 ± 0.002	0.203 ± 0.006	0.144 ± 0.001	0.082 ± 0.008	0.169 ± 0.019 DE
V_{10}	0.266 ± 0.002	0.203 ± 0.011	0.138 ± 0.006	0.077 ± 0.002	0.171 ± 0.021 CDE
V_{11}	0.241 ± 0.009	0.200 ± 0.008	0.142 ± 0.008	0.077 ± 0.005	0.165 ± 0.019 E
V_{12}	0.312 ± 0.007	0.236 ± 0.001	0.174 ± 0.005	0.122 ± 0.003	0.211 ± 0.021 A
Mean	0.258 ± 0.004A	0.208 ± 0.002B	0.151 ± 0.003C	0.088 ± 0.003D	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05)

Table 6. Comparison of means root dry weight.

Variety	Treatment				Mean
	T_0	T_2	T_3	T_4	
V_1	0.180 ± 0.003	0.127 ± 0.004	0.084 ± 0.005	0.047 ± 0.002	0.109 ± 0.015 BC
V_2	0.186 ± 0.007	0.130 ± 0.003	0.082 ± 0.004	0.062 ± 0.009	0.115 ± 0.015 B
V_3	0.179 ± 0.005	0.131 ± 0.005	0.089 ± 0.004	0.049 ± 0.002	0.112 ± 0.015 BC
V_4	0.188 ± 0.002	0.129 ± 0.001	0.089 ± 0.004	0.042 ± 0.006	0.112 ± 0.016 BC
V_5	0.183 ± 0.006	0.130 ± 0.005	0.088 ± 0.003	0.047 ± 0.003	0.112 ± 0.015 BC
V_6	0.178 ± 0.001	0.128 ± 0.003	0.080 ± 0.000	0.056 ± 0.001	0.110 ± 0.014 BC
V_7	0.192 ± 0.003	0.130 ± 0.005	0.086 ± 0.001	0.043 ± 0.002	0.113 ± 0.017 B
V_8	0.186 ± 0.006	0.133 ± 0.003	0.080 ± 0.003	0.047 ± 0.002	0.111 ± 0.016 BC
V_9	0.182 ± 0.006	0.134 ± 0.006	0.087 ± 0.003	0.047 ± 0.006	0.113 ± 0.016 B
V_{10}	0.186 ± 0.003	0.130 ± 0.002	0.083 ± 0.004	0.053 ± 0.002	0.113 ± 0.015 B
V_{11}	0.179 ± 0.005	0.126 ± 0.003	0.080 ± 0.002	0.041 ± 0.002	0.106 ± 0.016 C
V_{12}	0.188 ± 0.007	0.142 ± 0.006	0.102 ± 0.003	0.056 ± 0.003	0.122 ± 0.015 A
Mean	0.184 ± 0.001A	0.131 ± 0.001B	0.086 ± 0.001C	0.049 ± 0.001D	

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

Table 7. Comparison of means shoot fresh weight.

Variety	Treatment				Mean
	T_0	T_2	T_3	T_4	
V_1	0.072 ± 0.001	0.061 ± 0.004	0.043 ± 0.002	0.029 ± 0.003	0.051 ± 0.005 ABC
V_2	0.073 ± 0.003	0.057 ± 0.004	0.046 ± 0.002	0.033 ± 0.002	0.052 ± 0.005 AB
V_3	0.069 ± 0.004	0.056 ± 0.003	0.040 ± 0.003	0.031 ± 0.003	0.049 ± 0.005 BC
V_4	0.074 ± 0.002	0.058 ± 0.003	0.047 ± 0.000	0.029 ± 0.003	0.052 ± 0.005 AB
V_5	0.073 ± 0.003	0.057 ± 0.000	0.043 ± 0.003	0.029 ± 0.001	0.051 ± 0.005 BC
V_6	0.071 ± 0.004	0.057 ± 0.002	0.044 ± 0.003	0.030 ± 0.003	0.051 ± 0.005 BC
V_7	0.077 ± 0.000	0.053 ± 0.007	0.041 ± 0.001	0.027 ± 0.002	0.049 ± 0.006 BC
V_8	0.073 ± 0.002	0.061 ± 0.002	0.041 ± 0.005	0.029 ± 0.003	0.051 ± 0.005 BC
V_9	0.067 ± 0.002	0.054 ± 0.004	0.041 ± 0.003	0.029 ± 0.002	0.048 ± 0.004 CD
V_{10}	0.072 ± 0.002	0.054 ± 0.002	0.046 ± 0.002	0.030 ± 0.002	0.051 ± 0.005 BC
V_{11}	0.068 ± 0.003	0.049 ± 0.001	0.037 ± 0.002	0.026 ± 0.001	0.045 ± 0.005 D
V_{12}	0.079 ± 0.001	0.062 ± 0.002	0.047 ± 0.002	0.032 ± 0.001	0.055 ± 0.005 A
Mean	0.072 ± 0.001A	0.057 ± 0.001B	0.043 ± 0.001C	0.029 ± 0.001D	

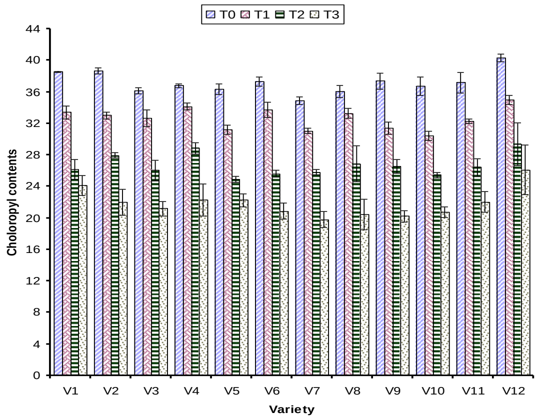
Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

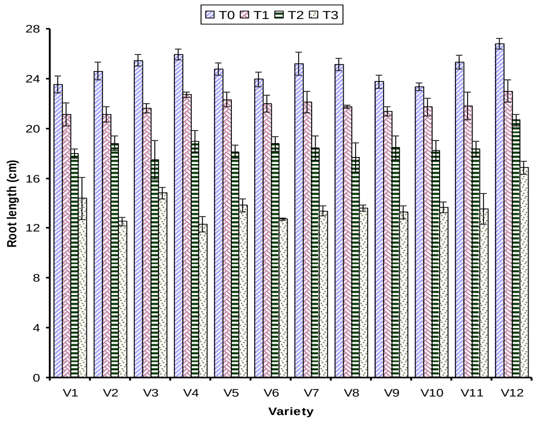
Table 8. Comparison of means for shoot dry weight.

Variety	Treatment				Mean
	T_0	T_2	T_3	T_4	
V_1	0.039 ± 0.001	0.031 ± 0.002	0.020 ± 0.002	0.010 ± 0.002	0.025 ± 0.003 BCD
V_2	0.038 ± 0.002	0.032 ± 0.001	0.021 ± 0.001	0.009 ± 0.002	0.025 ± 0.003 BCD
V_3	0.037 ± 0.002	0.031 ± 0.002	0.020 ± 0.002	0.009 ± 0.002	0.024 ± 0.003 CDE
V_4	0.039 ± 0.003	0.032 ± 0.001	0.023 ± 0.000	0.011 ± 0.002	0.026 ± 0.003 ABC
V_5	0.037 ± 0.002	0.033 ± 0.000	0.019 ± 0.001	0.011 ± 0.002	0.025 ± 0.003 BCD

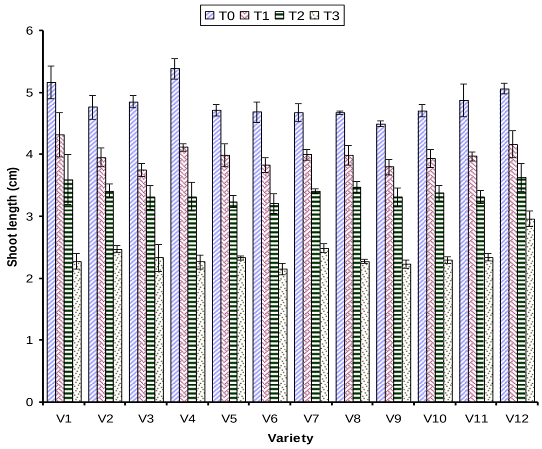
Variety	Treatment												Mean		
	T_0			T_2			T_3			T_4					
V_6	0.038	±	0.001	0.030	±	0.002	0.021	±	0.002	0.011	±	0.002	0.025	±	0.003 BCD
V_7	0.037	±	0.000	0.033	±	0.000	0.020	±	0.002	0.011	±	0.003	0.025	±	0.003 BCD
V_8	0.038	±	0.002	0.030	±	0.002	0.021	±	0.002	0.007	±	0.000	0.024	±	0.004 DE
V_9	0.040	±	0.000	0.033	±	0.000	0.020	±	0.002	0.013	±	0.000	0.027	±	0.003 AB
V_{10}	0.032	±	0.002	0.031	±	0.001	0.018	±	0.001	0.007	±	0.000	0.022	±	0.003 E
V_{11}	0.039	±	0.001	0.032	±	0.001	0.021	±	0.003	0.008	±	0.001	0.025	±	0.004 BCD
V_{12}	0.041	±	0.001	0.033	±	0.000	0.023	±	0.000	0.013	±	0.000	0.028	±	0.003 A
Mean	0.038	±	0.001A	0.032	±	0.000B	0.021	±	0.000C	0.010	±	0.001D			

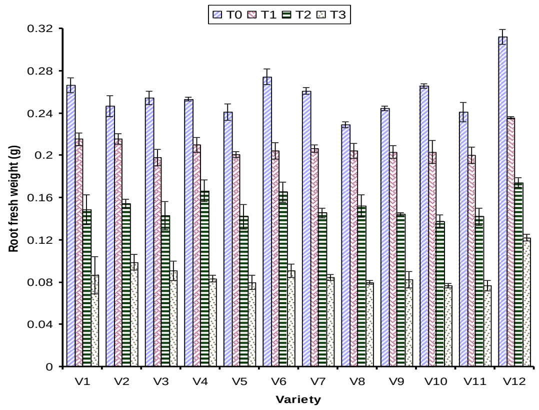
Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).



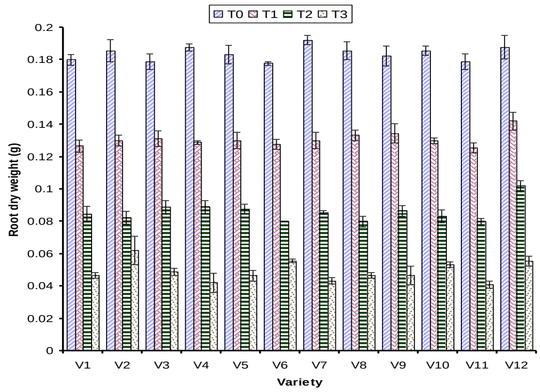


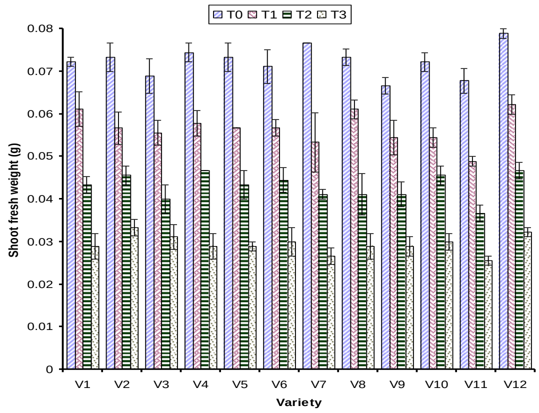
Effect of salinity on chlorophyll contents Effect of salinity on root length.



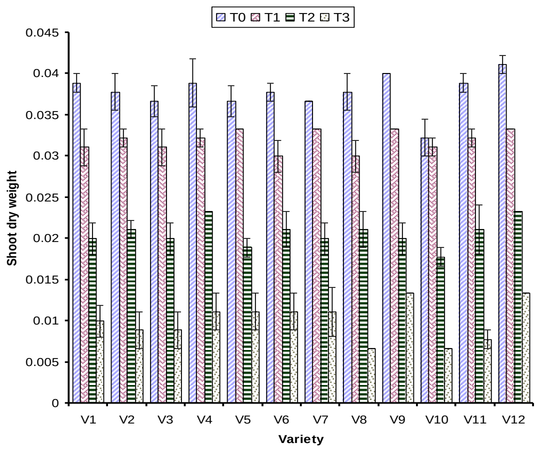


Effect of salinity on shoot length Effect of salinity on root fresh weight.





Effect of salinity on root dry weight Effect of salinity on shoot fresh weight.



Effect of salinity on shoot dry weight.

Discussion

The effects of salinity are devastating in arid and semiarid environments (Azhar *et al*., 2007). About 5% of cultivated land in the world is salinized, primarily due to insufficient drainage and low quality irrigation water (Binzel & Reuveni, 1994). To feed growing populations, marginal lands are to be brought under cultivation, which are not cropped due to their high degree of natural salinity or other toxicities (Flowers & Yeo, 1995). Pakistan is situated within the subtropical region with semi-arid to arid climate. According to a recent survey, of the 16.795 million ha irrigated area in Pakistan, 73% is categorized as non saline, 10% as slightly saline, 4% as moderately saline, 7% as strongly saline and 6% as miscellaneous type area (Anon., 2007). The saline soils contain mixture of different salts (Sandhu & Qureshi, 1986) but in Pakistan more than 60% soils are sodic and salinity stress is mostly due to Na+ salts (Plaut, 1993).

For affecting salt tolerance in a crop there must be sufficient genetic variation within the crop in response to salt, and this variation should be genetically controlled, to make selection and breeding possible for a target trait (Epstein & Norlyn, 1977; Shannon, 1978; Epstein *et al*., 1980). The treatment effects were important for the control of salinity tolerance in the 12 genotypes assessed at the seedling stage of wheat. The data indicated that treatment effects were significant for the chlorophyll contents, root length, shoot length, root fresh weight, root dry weight, shoot fresh weight and shoot dry weight in control and NaCl concentrations (Tables 2, 3, 4, 5, 6, 7 & 8). It is clearly indicated that there was great difference among the wheat genotypes for all the parameters studied in the experiment. As the concentration of NaCl salt was increased, it significantly decreased root length, shoot length, root fresh weight, root dry weight, shoot fresh weight, shoot dry weight and chlorophyll contents. Salt susceptible genotypes build up ions more rapidly than salt tolerant genotypes which cause leaf death and eventually plant death which gradually decrease in length and weight of root and shoot (Munns, 2002). Application of salt stress have overall substantial negative effect on all morphological and biochemical parameters of the wheat crop (Rafiq *et al*., 2006). Increasing NaCl concentration adversely affected shoot dry weight and root dry weight of wheat genotypes (Akbarimoghaddam *et al*., 2011)

Conclusion

The results of our study concluded that screening is an effective tool to exploit genetic variation among wheat genotypes. These variations can further be utilized in a breeding programme to develop high yielding salt tolerant genotypes of wheat through selection and breeding procedures. Our findings will provide guidelines about selection of salt tolerant hybrids in wheat and this information will be very necessary and relevant to plant breeders and physiologists who are indulged in improving salt tolerance of wheat. This criterion is also applicable for other crops to develop high yielding salt tolerant varieties.

References

Akbarimoghaddam H, Galavi H, Ghanbari, Panjehkeh AN. 2011. Salinity effects on seed germination and seedling growth of bread wheat cultivars. Trakia Journal of Sciences **9(1),** 43-50.

Anonymous. 2007. Agricultural Statistics of Pakistan. MINFAL, Islamabad, Pakistan.

Azhar FM, Khan AA, Saleem N. 2007. Genetic mechanism controlling salt tolerance in *Gossypium hirsutum* L. seedlings. Pakistan Journal of Botany **39,** 115-121.

Binzel ML, Reuveni M. 1994. Cellular Mechanism of salt tolerance in plants. Horticultural Reviews **16,** 38: 33-69.

Epstein E, Norlyn JD. 1977. Sea-water based crop production: A feasibility study. Science **197,** 249-251.

Epstein E, Rush DW, Kingsbury RW, Kellery DB, Cunningham GA, Worna AF. 1980. Saline culture of crops: A genetic approach. Science **210,** 399-404.

Flowers TJ, Yeo AR. 1995. Breeding for salinity resistance in crop plants where next? Australian Journal of Plant Physiology **22,** 875-884.

Forster BP, Gorham, Miller TE. 1987. Salt tolerance of an amphiploid between *Triticum aestivum* and *Agropyron junceum*. Plant Breeding **98,** 1-8.

Gul B, Weber DJ. 1999. Effect of salinity, light, and temperature on germination in *Allenrolfea occidentalis*. Canadian Journal of Botany **77,** 240-246.

Katerji N, Mastrorilli M, Horn JW, Lahmer FZ, Hamdy A, Oweis T. 2009. Durum wheat and barley productivity in saline -drought environments. European Journal of Agronomy **31,** 1-9.

Kronstad WE. 1998. Agricultural development and wheat breeding in the 20th century. pp. 1-10. In Braun, H.-J., F. Altay, W. E. Kronstad, S. P. S. Benival, and A. Mc NAb (Eds.) Wheat: Prospects for global improvement. Proc. of the 5th Int. Wheat Conf., Ankara, Turkey, Developments in Plant Breeding v. 6. Kluwer Academic Publishers Dordrecht.

Machlalan S, Zalic S. 1963. Plastid structure, chlorophyll concentration and the amino acid composition of chlorophyll mutant barley. Canadian journal of Botany **41,** 1053-1062.

Mass EV. 1986. Salt tolerance of plants. Applied Agricultural Research **1,** 12-26.

McKinney G. 1940.Criteria for purity of chlorophyll preparation. Biology **132,** 91-107.

Munns R, Richard AJ, Lauchli A. 2006. Approaches to increasing the salt tolerance of wheat and other cereals. Journal of Experimental Botany **57(5),** 1025-1043.

Munns R. 2002. Comparative physiology of salt and water stress. Plant Cell and Environment **25,** 239-250.

Munns, R, James RA. 2003. Screening methods for salt tolerance: a case study with tetraploid wheat. Plant and Soil **253,** 201-218.

Plaut Z. 1993. Photosynthesis in plant/crops under water and salt stress. In: Handbook of Plant and Cop Physiology. (Ed.): M. Pessarakli. Marcel Dekker Inc., New York pp. 587-602.

Qureshi RH. Barrett-Lennard EG. 1998. Saline agriculture for irrigated land in Pakistan: a handbook. Monograph No. 50. Canberra: Australian Centre for International Agricultural Research.

Rafiq S, Iqbal T, Hameed A, Rafiqi ZA, Rafiq N. 2006. Morphobiochemical analysis of salinity stress response of wheat. Pakistan Journal of Botany **38(5),** 1759-1767.

Rengasamy P. 2006. World salinization with emphasis on Australia. Journal of Experimental Botany **57,** 1017-1023.

Rosegrant MW, Agcaoili-Somlilla A, Perez N. 1995. Global food projections to 2020. Discussion paper v. 5. IFPRI WA.

Sandhu GR, Qureshi RH. 1986. Salt affected soils of Pakistan and their utilization. Process Review and Res **5,** 106.

Schachtmann DP, Munns R. 1992. Sodium accumulation in leaves of *Triticum* species that differ in salt tolerance. Australian journal of Plant Physiology **19,** 331-340.

Shannon MC. 1978. Testing salt tolerance variability among long wheatgrass lines. Agronomy journal **70,** 719-722.

Steel L, Martill DM, Kirk JR, Anders JA, Loveridge RF, Frey E, Martin JG. 1997. Arambourgianiaphiladelphiae: giant wings in small halls. The Geological Curator **6,** 305-313.

Steel RGD, Torrie JH, Dickey DA. 1997. Principles and procedures of statistics. A biometric approach 3rd Ed. McGraw Hill Book Co. Inc. New York.

Torech FR. Thompson LM. 1993. Soils and Soil Fertility. Oxford University Press, New York 15.

Ungar IA. 1996, Effects of salinity on seed germination, growth, and ion accumulation of *Atriplex patula* (Chenopodiaceae). American Journal of Botany **83,** 62-67.

Wyn Jones RG,Storey R. 1981. Betaines. In: Physiology and Biochemistry of Drought Resistance in Plants. (Eds.): L.G. Paleg and D. Aspinall. (Eds.). Academic Press, Sydney pp. 171-204.

Yamaguchi T, Blumwald E. 2005. Developing salt-tolerant crop plants: challenges and opportunities. Tren. Plant Sciences **10,** 615-620.

Zeb B, Khan IA, Ali-Bacha SS, Mumtaz S. Swati ZA. 2009. Study on genetic diversity in Pakistani wheat varieties using simple sequence repeat (SSR) markers. African Journal of Biotechnology **8(17),** 4016-4019.