### INTRODUCTION

Salinity stress reduces the plant growth productivity and efficiency of crops around the world (Machado & Serralheiro, 2017) and affects more than 800 million ha of land in the world which is equal to 6% of the whole world (FAO, 2011). Crops grown on salt affected areas undergo high osmotic stress, ionic toxicities, poor physical conditions of soil and decreased production (Shrivastava & Kumar, 2015). Salinity is one of the major environmental issue influencing plant development and efficiency (Ahanger et al., 2017; Aliakhverdiev, Sakamoto, Nishiyama, & Murata, 2000). It has been estimated that in salinity stressed soils, the concentration of Na$^+$ and Cl$^-$ is higher accompanied with the decreased concentration of K$^+$ and K+: Na$^+$ ratio thus adversely affecting the plant growth (Saqib, Akhtar, & Qureshi, 2004). Salt stress affects plant
physiological mechanism, such as increased rate of respiration and ionic toxicity, changes in plant growth, mineral distribution, cause displacement of calcium and potassium ions by sodium (Acosta-Motos et al., 2017), membrane instability and diminished photosynthetic productivity (Ashraf & Shahbaz, 2003).

Wheat (*Triticum aestivum* L.) is an important cereal crop all over the world (Giraldo, Benavente, Manzano-Agugliaro, & Gimenez, 2019). Wheat growth is affected by soil conditions and water availability (Akhkha, Boutraa, & Alhejely, 2011). Likewise, in Pakistan, it is the real staple food and developed on a region of 9,260 thousand ha (ICAR, 2016). Wheat is a quite salinity tolerant crop and it has significant genotypic difference for salinity tolerance (Saqib, Akhtar, & Qureshi, 2004). It ranks first in acreage as well as production amongst all the cereals grown in Pakistan (Rehman et al., 2015). Annual wheat production in Pakistan was 24,214 thousand tons and area under cultivation was 8,805 thousand ha in 2010-2011 (Ministry of Finance, 2011). Wheat production in Pakistan is quiet low in the salt-affected areas and yield losses up to 65% have been recorded in moderately saline soils (Shafi, Bakht, Khan, Khan, & Anwar, 2010). However, if genetic variability in wheat is explored extensively, the productivity of these saline areas would be increased to a great extent. Use of improved varieties and better agronomic practices during the past four decades has boosted the total wheat production of the country. Wheat production increased by 1.58% as compared to negative growth of -3.44% last year (Asad, Mahmood, & Mudassar, 2017). However, due to increasing salinity and growing population, there is still a need to increase wheat production in the country. The detrimental effects of salinity stress on the growth and total production of wheat are well documented whereas a little information is available regarding to its effects on grain quality. With the improved life style consumer concerns for the better quality have also been increased (Park, Wilson, & Seabourn, 2009). Keeping in view of the information the present study was undertaken to compare the growth performance and grain yield of various wheat genotypes under salinity stress and investigate salinity-induced changes in the nutritional quality of wheat (*Triticum aestivum* L.) genotypes.

**MATERIALS AND METHODS**

**Plant Material and Treatments**

A pot experiment was conducted at the research farm of the Department of Environmental Sciences, COMSATS University Islamabad (CUI) Vehari from November 2017 to December 2018. In this study four wheat (*Triticum aestivum* L.) genotypes (SARC-1), (SARC-5), (SARC-7), and (SARC-8) were grown with following treatments: T1 = Control; T2 = Saline (ECe 7.5 dS/m); T3 = Saline (ECe 15 dS/m).

Level of salinity was established based upon initial electric conductivity of soil, saturation percentage and final electric conductivity. Salinity levels were created artificially by adding sodium chloride in normal soil (pH 8.2) before filling in the pots. Each pot contained 7 kg of soil. The recommended fertilizers N (120 kg/ha), P (100 kg/ha) and K (60 kg/ha) were applied in the form of Urea, DAP, and SOP in both saline and non-saline treatments. Three plants were maintained in each pot. Pots were irrigated with tap water every week and management practices (hoeing, weed eradication) were followed.

**Growth Attributes of Wheat**

Wheat was grown up to maturity and biological yield and grain yield was measured at the time of harvesting. Biological yield was measured at maturity. Numbers of grains per spikes were measured at maturity. Thousand grain weights were measured at maturity. Grain length was measured at maturity.

**Milling of Wheat Grains**

The grains of each wheat genotype were tempered to 15.5% moisture level according to AACC (2000) method No. 26-95. The tempered wheat grains were milled through a Brabender Quadrumate Senior Mill. The straight grade flour was obtained by blending the two flour millstreams i.e. break roll flour and reduce roll flour.

**Chemical Attributes of Wheat Grains**

The moisture content, ash content, crude protein content, crude fiber content and crude fat content in each sample was estimated by the procedure given in AACC (2000) by method No. 44-15A, method No. 08-01, method No 46-10, method No. 32-10 and method No. 30-25 respectively.
Wet and Dry Gluten

The wet and dry gluten content in each wheat flour sample were determined by using the Glutomatic System (Perten, GM-2200) by following the procedure given in AACC (2000) method 38-12.02. Ten grams well mixed flour sample was added onto the screen. Sample was spread out over screen by shaking wash chamber in circular motion. And then, 4.8 ml wash solution was added from dispenser while holding chamber at about 30° angle to prevent loss of liquid through screen. The sample was shaking gently in a circular motion to spread liquid over total top surface of the sample. The washing chamber was assembled onto glutomatic apparatus and the apparatus was run automatically for 20 seconds dough mixing and for 5 minutes gluten washing. At the end of wash cycle, the chamber was lowered and gluten was removed from chamber and was placed in centrifuge. The sample was centrifuged at 6000 rpm for 1 minute. Then gluten index cassette was removed from centrifuge and gluten was removed that was passed through the sieve and was weighed as weak wet gluten while gluten remaining on the top of sieve, was weighed as strong gluten. Weight of both weak and strong gluten was recorded as total wet gluten. Then the total amount of wet gluten was placed in a lower heating surface of dryer and was dried at 150°C for 4 minutes. Gluten was removed from dryer as dry gluten. The total wet gluten and dry gluten contents were calculated according to the following expression:

\[
\text{Wet gluten contents } \% = \frac{\text{Total wet gluten (g) } \times 860}{100 - \% \text{ sample moisture}}
\]

\[
\text{Dry gluten contents } \% = \frac{\text{Total wet gluten (g) } \times 860}{100 - \% \text{ sample moisture}}
\]

Gliadin and Glutenin

Flour gliadin and glutenin were determined according to Suchy et al. (2007). Eight mg of flour was weighed and poured into 3 ml microcentrifuge test tube and 1.44 ml of 50% (v/v) propan-1-01 solution as a blank. This fraction, called 50PS, contains most of the monomeric protein (mostly gliadin) and small amount of glutenin.

Sodium Dodecyl Sulfate (SDS)-Sedimentation Test

The SDS-Sedimentation test for wheat varieties was carried out by following the method described by Williams, El-Haramein, Nakkoul, & Riawah (1986).

Mineral Attributes of Wheat Grains

The wheat flour samples were further analyzed for mineral content by following AACC (2000) methods as: iron (Method No. 985.01), zinc (Method No. 991.11), magnesium (Method No. 968.08), phosphorous (Method No. 965.17). Two grams of sample was digested with 7 ml concentrated nitric acid and 3 ml perchloric acid on hot plate at temperature up to 200°C till coloring become transparent. This was brought to volume in a 100 ml volumetric flask with distilled water. Determination of minerals was done using the 1% digest solution in Atomic Absorption Spectrophotometer (Model: Varian, AA-240). Sodium, Potassium and Calcium were determined with flame photometer (Jenway PFP -79). A graded series of standards of NaCl was prepared and standard curve was drawn. The values of Na, K and Ca from Flame photometer were compared for standard curve and total quantities were computed.

Statistical Analysis

The data obtained for each parameter was analyzed by suitable Statistical Package Co-Stat-2003 (Cohort v-6.1) using factorial design and the analysis of variance was applied to determine the level of significance (Steel, Dickey, & Torrie, 1997).

RESULTS AND DISCUSSION

Growth Attributes of Wheat

The highest biological yield (26.56 g) was found in SARC-8, but the wheat genotype SARC-5 showed significantly the lowest biological yield (5.36 g). Highest biological yield (26.56 g) was observed in T1 (control) and it decreased significantly by increasing the level of salinity from T2 (20.27 g) to T3 (16.87 g) (Table 1). Results showed that biological yield decreased significantly by increasing salinity stress. Salts are present in greater amount in the soil; they affect all the plant growth stages by
decreasing germination (Murillo-Amador et al., 2000), leaf cell expansion, and growth of leaves (Cramer & Nowak, 1992).

**Grain Yield**

The results (Table 1) pertaining to grain yield in different wheat genotypes revealed that it ranged from 1.68 to 14.88 g in all wheat genotypes. The highest grain yield 14.88 g was observed in wheat genotype SARC-8 while the lowest grain yield (1.68 g) was observed in wheat genotype SARC-5. In case of T₁ (control) maximum grain yield (14.88 g) was observed and it decreased significantly by increasing the level of salinity from T₂ (11.09 g) to T₃ (9.03 g). The data according to the biological yield that grain yield decreased significantly with increasing salinity level. Similar to Hamza & Elahmadi (2014) found that salinity stress affected the numbers of spikes, number of grains per spike and decrease 1000-grain weight. Similarly, salinity stress hastened all the phenological characters studied and decrease grain yield, harvest index and biomass.

**Number of Grains per Spikes**

The results (Table 1) shows that the number of grains per spikes ranged from 19.24 to 46.60 among different wheat genotypes. Significantly the highest number of grains per spike (46.60) was observed in wheat genotype SARC-8 while the wheat genotype SARC-5 showed significantly the lowest number of grains per spike (19.24). In case of T₁ (control) number of grains per spike (46.60) was found and decreased significantly by increasing the level of salinity from T₂ (37.97) to T₃ (30.24). Salinity stress hinders photosynthetic efficiency as well as it assimilates translocation capacity of plant from vegetative part to reproductive part. For these reason the numbers of grains decrease in developed spike which is much similar to Naseer, Rasul, & Ashraf (2001) reported that the number of total grains per spike decreased progressively with the increasing of salinity level.

**Grain Length**

Results of grain length ranged from 0.50 to 0.96 cm in different wheat genotypes. The results (Table 1) showed that the highest grain length (0.96 cm) was found in SARC-8, but the wheat genotype SARC-5 showed significantly the lowest grain length (0.50 cm) when data of four genotypes was calculated. In case of control treatment, maximum grain length (0.96 cm) was observed among different wheat genotypes and under salinity stress, the grain length decreased from 0.77 cm to 0.63 cm in T₂ and T₃ respectively. Data regarding grain length indicated that biological yield decreased significantly with the increasing salinity level. Salinity stress affected the size of the seeds. Seed size was reduced with increasing salinity stress and grain length was reduced with the increased salinity level (Hassan, 2004).

Table 1. Salinity-induced changes in the growth attributes of wheat (*Triticum aestivum* L.) genotypes

| Treatments | Varieties | Biological yield (g) | Grain yield (g) | Number of grains per spike | Grain length (cm) | 1000-grain weight (g) |
|------------|-----------|----------------------|-----------------|---------------------------|------------------|-----------------------|
| T₁         | SARC-1    | 20.71 b              | 10.93 b         | 40.18 abc                 | 0.79 bc          | 49.30 ab              |
|            | SARC-5    | 14.74 d              | 6.86 de         | 36.72 de                  | 0.69 d           | 40.61 c               |
|            | SARC-7    | 23.47 ab             | 13.44 a         | 44.28 ab                  | 0.86 b           | 46.25 b               |
|            | SARC-8    | 26.56 a              | 14.88 a         | 46.60 a                   | 0.96 a           | 52.01 a               |
| T₂         | SARC-1    | 15.48 d              | 8.29 cd         | 31.09 def                 | 0.66 de          | 36.43 cd              |
|            | SARC-5    | 10.00 e              | 5.15 e          | 25.13 fgh                 | 0.60 efg         | 35.57 cd              |
|            | SARC-7    | 17.14 cd             | 9.79 bc         | 35.02 cde                 | 0.71 cd          | 39.89 c               |
|            | SARC-8    | 20.27 bc             | 11.09 b         | 37.97 bcd                 | 0.77 fgh         | 46.31 b               |
| T₃         | SARC-1    | 8.57 ef              | 4.54 e          | 23.39 gh                  | 0.55 gh          | 26.49 e               |
|            | SARC-5    | 5.36 f               | 1.68 f          | 19.24 h                   | 0.50 h           | 29.04 e               |
|            | SARC-7    | 14.12 d              | 7.50 cd         | 24.63 fgh                 | 0.57 fgh         | 34.51 d               |
|            | SARC-8    | 16.87 d              | 9.03 bcd        | 30.24 efg                 | 0.63 def         | 40.75 c               |

Remarks: T₁ = Control (ECₑ 0 dS/m), T₂ = Saline (ECₑ 7.5 dS/m), T₃ = Saline (ECₑ 15 dS/m); Means carrying same letters in a column are not significantly different.
1000-Grain Weight
The results indicated that 1000-grain weight ranged from 26.49 g to 52.01 g among different wheat genotypes. Notably, the highest 1000-grain weight (52.01 g) was found in wheat genotype SARC-8 while the lowest 1000-grain weight (26.49 g) was found in wheat genotype SARC-1. The maximum 1000-grain weight (52.01 g) is observed in control treatment which decreases significantly by increasing the salinity from T₂ (46.31 g) to T₃ (40.75 g) in all genotypes (Table 1). The current results are in line with the findings of Hamza & Elahmadi (2014), they reported numbers of spikes, number of grains per spike and decrease 1000-grain weight that salinity stress affected similarly salinity also influence phonological characters studied and decrease grain yield, harvest index and biomass. Salinity stress affected the size of the seeds. Seed size was reduced with the increasing of salinity stress. Hassan (2004) studied that grain weight was reduced by increasing salinity level.

Nutritional Attributes of Wheat Grains
Moisture Content in Wheat Grain
It is obvious from the results that moisture content ranged from 7.67 to 13.37% in different wheat genotypes. Results indicated that the highest moisture content (13.37%) was found in SARC-1, but the wheat genotype SARC-7 showed significantly the lowest moisture contents (7.67%), when data of four genotypes was calculated (Table 2). Maximum moisture content (13.37%) was found in T₁ (control) and decreased significantly by increasing the level of salinity from T₂ (12.16%) to T₃ (10.05%) respectively. Arzani (2008) and Katerji, van Hoorn, Hamdy, & Mastrorilli (2004) reported that excessive Na in the plant tissue change nutrient balance, osmotic regulation and causes specific ion toxicity. Water deficit in plants due to low external water potential is considered to be the first cause of growth inhibition under saline conditions (Chen, Wang, Yin, & Deng, 2018).

Ash Content in Wheat Grain
The results (Table 2) pertaining to ash content in different wheat genotypes reveals that it ranges from 0.29% to 0.95%. The highest ash content (0.95%) was observed in wheat genotype SARC-1 while the wheat genotype SARC-7 showed remarkably the lowest ash content (0.29%). Ash content (0.95%) was significantly higher in T₁ (control) but decreased significantly by increasing salinity stress from T₂ (0.72%) to T₃ (0.40%). Arzani (2008) and Katerji, van Hoorn, Hamdy, & Mastrorilli (2004) reported that excessive Na in the plant tissue change nutrient balance, osmotic regulation and causes specific ion toxicity. Ash contents decrease due to salinity in all wheat genotypes (Salehi & Arzani, 2013).

Table 2. Salinity-induced changes in the chemical attributes of wheat (Triticum aestivum L.) genotypes

| Treatments | Varieties | Moisture Content (%) | Ash Content (%) | Crude fat content (%) | Crude Fiber Content (%) | Crude Protein Content (%) |
|------------|-----------|----------------------|----------------|-----------------------|------------------------|---------------------------|
| T₁         | SARC-1    | 13.37 a              | 0.95 a         | 0.89 a                | 0.79 a                 | 10.26 h                   |
|            | SARC-5    | 11.96 ab             | 0.85 b         | 0.80 b                | 0.54 cd                | 11.33 efg                 |
|            | SARC-7    | 10.73 bc             | 0.71 c         | 0.84 ab               | 0.63 b                 | 11.94 cdef                |
|            | SARC-8    | 13.16 a              | 0.80 bc        | 0.82 b                | 0.63 b                 | 10.01 h                   |
| T₂         | SARC-1    | 12.16 ab             | 0.72 c         | 0.64 c                | 0.61 bc                | 11.13 fg                  |
|            | SARC-5    | 11.09 bc             | 0.60 d         | 0.55 d                | 0.43 ef                | 11.84 def                 |
|            | SARC-7    | 9.13 de              | 0.47 ef        | 0.62 c                | 0.51 de                | 12.73 abc                 |
|            | SARC-8    | 10.27 cd             | 0.55 de        | 0.58 cd               | 0.34 g                 | 10.52 gh                  |
| T₃         | SARC-1    | 10.05 cd             | 0.40 fg        | 0.44 e                | 0.39 fg                | 12.58 bcd                 |
|            | SARC-5    | 7.85 e               | 0.39 fg        | 0.34 f                | 0.36 fg                | 13.01 ab                  |
|            | SARC-7    | 7.67 e               | 0.29 h         | 0.41 e                | 0.43 ef                | 13.44 a                   |
|            | SARC-8    | 9.74 cd              | 0.31 gh        | 0.38 ef               | 0.24 h                 | 12.02 cde                 |

Remarks: T₁ = Control (ECe 0 dS/m), T₂ = Saline (ECe 7.5 dS/m), T₃ = Saline (ECe 15 dS/m); Means carrying same letters in a column are not significantly different.
Crude Fat Content of Wheat Grain

It is apparent from the results (Table 2) that fat content ranged from 0.34% to 0.89% in different wheat genotypes. In case of treatments, the maximum fat content (0.89%) among wheat genotypes was observed in T1 (control) and the fat content decreased under salinity stress from 0.64% to 0.44% in T2 and T3 respectively. Salinity induced significant influences on crude fat. Previously different wheat genotypes have been found to vary from 0.09% to 1.37% (Baе, 2010). Soil salinity causes the ionic imbalance which reduces the metabolic activities and water absorption in plants causing the deficiency of major plant nutrients (Saqib, Akhtar, Qureshi, Aslam, & Nawaz, 2000). Abbas et al. (2013) reported that quality parameters including grain protein, fat and fiber contents were decreased in response to salinity.

Crude Fiber Content in Wheat Grain

The results (Table 2) regarding fiber content of different wheat genotypes showed that fiber contents ranged from 0.24% to 0.79% among different wheat genotypes. In case of treatment, T1 (control) showed maximum crude fiber contents (0.79%) and salinity stress decreased fiber contents from T2 (0.61%) to T3 (0.39%) among different wheat genotypes. Eleiwa, Bafee, & Ibrahim (2011) showed that the salinity in the irrigation water significantly reduce chemical contents of wheat grains when comparing with control treatment which irrigated with tap water. Salinity resulted in a significant decrease of the grain protein, fat and fiber content (Abbas et al., 2013).

Crude Protein Content in Wheat Grain

The results showed that protein content ranged from 10.01% to 13.44% among different wheat genotypes. The highest protein (13.44%) content was found in wheat genotype SARC-7 while lowest protein content (10.01%) was found in wheat genotype SARC-8. In case of T1 (control) the lowest protein content (10.01%) was observed and these contents increased significantly by increasing the level of salinity from T1 (10.52%) to T3 (12.02%) (Table 2). Protein content increased by increasing the salinity level was related to Salehi & Arzani (2013) that quality and quantity of protein is important to find dough properties and bread making properties. Salinity stress increased the quantity of protein but decreased quality of protein. Salinity stress cause positive or negative effects on protein.

Wet Gluten Content in Wheat Grain

The results (Table 3) showed that wet gluten content ranged from 23.89% to 28.47% among different wheat genotypes. Significantly, higher wet gluten contents 28.47% were observed in wheat genotype SARC-1 while significantly the lower wet gluten contents 23.89% were observed in SARC-5 among all wheat genotypes. Minimum wet gluten content 23.89% was observed in T1 (control) while gluten contents increased by increasing salinity stress from T2 (24.91%) to T3 (25.84%). It is related to Houshmand, Arzani, & Mirmohammadi-Malibody (2014) both drought and salt stresses increased wet and dry gluten content of genotypes.

Table 3. Salinity-induced changes in the gluten attributes of wheat (Triticum aestivum L.) genotypes

| Treatments | Varieties | Wet (%) | ± SE | Dry (%) | ± SE | Glutenin (%) | Gliadin (%) | SDS (ml) |
|------------|-----------|---------|------|---------|------|--------------|-------------|----------|
| T1         | SARC-1    | 26.85 de| 0.8  | 8.15 fg | 0.02 | 0.27 ab      | 0.21 g      | 26.54 de |
|            | SARC-5    | 23.89 e | 0.7  | 8.48 ef | 0.36 | 0.29 a       | 0.21 g      | 29.43 a  |
|            | SARC-7    | 24.98 d | 0.9  | 7.35 h  | 0.21 | 0.21 cde     | 0.23 fg     | 29.47 a  |
|            | SARC-8    | 23.91 e | 0.7  | 7.17 h  | 0.24 | 0.23 bcd     | 0.28 de     | 25.51 ab |
| T2         | SARC-1    | 26.85 bc| 0.7  | 8.52 ef | 0.56 | 0.21 de      | 0.29 d      | 24.15 fgh|
|            | SARC-5    | 24.91 de| 0.6  | 9.16 cd | 0.09 | 0.36 abc     | 0.25 ef     | 27.02 cd |
|            | SARC-7    | 25.89 cd| 0.5  | 7.98 g  | 0.51 | 0.22 bcde    | 0.28 de     | 28.07 bc |
|            | SARC-8    | 25.52 d | 0.6  | 8.61 ef | 0.65 | 0.18 ef      | 0.34 bc     | 25.36 ef |
| T3         | SARC-1    | 26.79 bc| 0.8  | 9.39 bc | 0.27 | 0.15 f       | 0.39 a      | 23.45 gh |
|            | SARC-5    | 25.84 cd| 0.9  | 9.92 a  | 0.14 | 0.22 bcde    | 0.27 de     | 23.51 gh |
|            | SARC-7    | 27.47 ab| 1.0  | 8.79 de | 1.15 | 0.20 def     | 0.38 ab     | 24.71 fg |
|            | SARC-8    | 26.79 bc| 0.8  | 9.39 bc | 0.27 | 0.15 f       | 0.39 a      | 23.45 gh |

Remarks: T1 = Control (ECe 0 dS/m), T2 = Saline (ECe 7.5 dS/m), T3 = Saline (ECe 15 dS/m); Means carrying same letters in a column are not significantly different.
Dry Gluten Content in Wheat Grain

The results (Table 3) revealed that dry gluten content varied from 7.17% to 9.69% among different wheat genotypes. Significantly, the maximum dry gluten content (9.69%) was observed in wheat genotype SARC-1 while the wheat genotype SARC-8 showed significantly the lowest dry gluten content (7.17%). Minimum dry gluten contents (7.17%) were observed in T1 (control) which increased by increasing the salinity stress from T2 (8.61%) to T3 (9.39%). Salehi & Arzani (2013) also reported that dry gluten contents of the genotypes were increased due to salinity.

Glutenin Content in Wheat Genotype

The results (Table 3) showed that glutenin content varied from 0.15% to 0.39% among different wheat genotypes. In present study, SARC-5 showed significantly the highest glutenin contents (0.36%) while the wheat genotype SARC-8 showed significantly the lowest glutenin contents (0.15%) among all genotypes. Salehi & Arzani (2013) suggested that salinity stress increased the gliadins at the expense glutenin which cause reduction in the dough strength. Salinity stress caused the reduction in duration of storage protein due to modification of accumulated gliadins and glutenin. Salinity stress increased gliadin but did not effect on glutenin but increased the proportion of gliadin to glutenin.

Gliadin Content in Wheat Grain

The results (Table 3) revealed that gliadin contents varied from 0.21% to 0.39% among different wheat genotypes. The highest gliadin contents (0.39%) were observed in the wheat genotype SARC-8 lowest gliadin contents (0.21%) in wheat genotype SARC-5 among all genotypes. Minimum gliadin contents (0.21%) were observed in T1 (control) and these contents increased significantly after increasing the salinity stress from T2 (0.25%) to T3 (0.27%). Salehi & Arzani (2013) suggested that salinity stress increased the gliadins at the expense glutenin which cause reduction in the dough strength. Salinity stress caused the reduction in duration of storage protein due to modification of accumulated gliadins and glutenin. Salinity stress increased gliadin but did not effect glutenin but increased the proportion of gliadin to glutenin.

SDS-Sedimentation Value in Wheat Grain

The results (Table 3) showed that SDS-Sedimentation value ranged from 23.27 to 29.47 ml among different wheat genotypes. Maximum SDS-Sedimentation value (29.47 ml) was found in wheat genotype SARC-7 while the SARC-1 showed significantly the lowest SDS-Sedimentation value (23.27 ml). Maximum SDS-Sedimentation value (29.47 ml) was found in T1 (control) and this value significantly decreased by increasing salinity stress from T2 (28.07 ml) to T3 (24.71 ml). Salinity effect on the volume of SDS-sedimentation was linked with a reduction in glutenin content of flour. SDS-sedimentation volume of both triticale and wheat genotypes decreased by salinity (Salehi & Arzani, 2013).
### Table 4. Salinity-induced changes in the mineral attributes of wheat (*Triticum aestivum* L.) genotypes

| Treatments | Varieties | Sodium (Na) (mg/kg) | Potassium (K) (ppm) | Calcium (Ca) (ppm) | Phosphorus (P) (ppm) | Iron (Fe) (ppm) | Magnesium (Mg) (ppm) | Zinc (Zn) (ppm) |
|------------|-----------|---------------------|---------------------|-------------------|---------------------|----------------|-------------------|----------------|
| T<sub>1</sub> | SARC-1 | 320.00±5.8cd | 4068.8±70.5bc | 484.50±8.5a | 3583.3±72.4a | 39.45±1.2a | 1375.0±9.1b | 45.38±1.1ab |
|            | SARC-5  | 229.00±4.3d | 4419.8±67.8a | 381.00±10.3cd | 3326.5±67.4abc | 35.30±2.4bc | 1149.8±11.3d | 34.71±1.2de |
|            | SARC-7  | 341.00±5.2bcd | 4020.8±68.9c | 442.50±9.3b | 3096.5±78.3cde | 36.86±0.9b | 1531.5±10.5a | 49.28±0.7a |
|            | SARC-8  | 361.25±4.9bc  | 4183.3±82.9b  | 384.00±7.5cd  | 3482.5±65.3ab  | 39.46±1.3a  | 1250.8±9.8c  | 38.52±1.4cd  |
| T<sub>2</sub> | SARC-1 | 363.75±4.2bc | 3863.8±65.4de | 391.25±8.2c | 3463.8±67.2ab | 32.78±1.4de | 1284.0±10.2c | 38.52±0.9cd |
|            | SARC-5  | 340.25±5.1bcd | 4095.3±76.4bc | 356.75±7.3ef | 3008.8±66.2de | 31.51±1.1e | 1316.8±11.4bc | 27.05±1.3g |
|            | SARC-7  | 407.75±5.8abc | 3818.0±72.8ef | 365.00±5.6de | 2701.3±72.4g | 34.10±0.8cd | 1374.3±9.3b | 42.64±0.8bc |
|            | SARC-8  | 415.25±6.2abc | 3989.3±69.2cd | 341.5±8.3f  | 3216.5±78.3bc | 34.91±1.0bcd | 1139.8±13.2d | 30.97±1.1ef |
| T<sub>3</sub> | SARC-1 | 402.25±6.4abc | 3692.5±71.3f | 316.75±6.7gh | 3001.3±69.4def | 26.11±1.5f | 1253.0±11.5c | 24.82±fg |
|            | SARC-5  | 383.25±5.3abc | 3790.0±53.9ef | 336.75±7.3fg | 2621.5±68.4g | 26.15±0.9f | 1296.3±13.2bc | 21.20±0.7g |
|            | SARC-7  | 447.25±4.3ab  | 3526.3±56.7g  | 307.75±6.9h  | 2731.8±56.3fg | 31.01±0.8e | 1284.3±9.1c  | 30.82±1.7ef |
|            | SARC-8  | 497.25±4.2a   | 830.5±62.8ef  | 312.25±5.9h  | 2873.3±61.9efg | 31.02±0.9e | 1051.5±11.3e | 28.30±0.9ef |

Remarks: T<sub>1</sub> = Control (ECe 0 dS/m), T<sub>2</sub> = Saline (ECe 7.5 dS/m), T<sub>3</sub> = Saline (ECe 15 dS/m); Values are given as Means±standard error (SE); Means carrying same letters in a column are not significantly different.
Calcium Content in Wheat Grain

The results presented that calcium content ranged from 307.75 to 484.50 ppm among different wheat genotypes. SARC-1 showed highest calcium contents but SARC-7 showed significantly the lowest calcium (307.75 ppm) (Table 4). In case of treatment, maximum calcium content (484.50 ppm) was observed in T1 (control) while these contents decreased by increasing salinity stress from T2 (391.25 ppm) to T3 (316.75 ppm). Sodium ions rapidly accumulate in plant tissues while potassium and calcium ion decreased due to salinity stress (Jamil et al., 2012).

Phosphorus Content in Wheat Grain

The results (Table 4) show that phosphorus contents range from 2621.5 to 3583.3 ppm among different wheat genotypes. Maximum phosphorus contents (3583.3 ppm) were observed in wheat genotype SARC-1 and minimum phosphorus contents (2621.5 ppm) observed in SARC-5. In case of treatment, maximum phosphorus content (3583.3 ppm) was found in T1 (control) which decreased significantly by increasing the level of salinity from T2 (3463.8 ppm) to T3 (3216.5 ppm). Salinity induced significant effects on phosphorus content in all genotypes, it decreased with increasing salinity. Hossain, Halim, Hossain, & Meher Niger (2006) studied that salinity affects normal physiological functions of wheat plants and imbalance in water relation and mineral ions accumulation. They found better physiological mechanisms associated with less affected water relation and mineral nutrition probably contributed for the higher salt tolerance genotypes in Aghrani than in Kanchan increased Mg contents by increasing salinity.

Iron Content in Wheat Grain

The results (Table 4) show that iron contents range from 26.11 to 39.46 ppm among different wheat genotypes. Maximum iron contents (39.46 ppm) were observed in wheat genotype SARC-8 but the lowest iron contents (26.11 ppm) found in SARC-1. Control treatment showed the maximum iron contents (39.4 ppm) while salinity stress decreases the iron contents from T3 (34.91 ppm) to T3 (31.02 ppm) in all wheat genotypes. According to Turan, Elkarim, Taban, & Taban (2010) that plant growth was not affected by low salt concentration of salt but maximum salinity level inhibited the growth and caused reduction in dry weight and nitrogen, potassium, calcium and iron.

Magnesium Content in Wheat Grain

The results (Table 4) show that magnesium contents range from 1051.5 to 1531.5 ppm among different wheat genotypes. Magnesium (1531.5 ppm) contents were observed significantly highest in wheat genotype SARC-7 while the wheat genotype SARC-8 showed significantly lowest magnesium (1051.5 ppm) contents. Maximum magnesium contents (1531.5 ppm) were found in control (T1) treatment which decreased significantly by increasing the level of salinity from T1 (1374.3 ppm) to T3 (1284.3 ppm). Salinity induced significant effects on magnesium content in all genotypes, it decreased with increasing salinity. Hossain, Halim, Hossain, & Meher Niger (2006) studied that salinity affects normal physiological functions of wheat plants and imbalance in water relation and mineral ions accumulation. They found better physiological mechanisms associated with less affected water relation and mineral nutrition probably contributed for the higher salt tolerance genotypes in Aghrani than in Kanchan increased Mg contents by increasing salinity.

Zinc Content in Wheat Grain

The results (Table 4) indicate that zinc contents range from 21.20 to 49.28 ppm among different wheat genotypes. Significantly highest zinc (49.28 ppm) content was found in wheat genotype SARC-7 while the lowest zinc (21.20 ppm) content was found in wheat genotype SARC-5. In case of treatment, maximum zinc content (49.28 ppm) was found in control treatment which decreased significantly by increasing salinity from T1 (42.64 ppm) to T3 (30.82 ppm) in all genotypes. Dar et al. (2012) also reported that maximum salt concentration of saline irrigation water reduces total zinc (Zn) and free Zn^{2+} concentrations in soil solution and also decrease the concentration of Zn in the wheat grain.

CONCLUSION

Salinity influence grain yield and quality among all genotypes. As salinity level increased the wheat genotypes showed their more susceptibility to salt in respect to the growth and chemical parameters including plant height, spike length, number of tillers and spikelets, grain yield, number of grain per spikes, 1000-grain weight, grain length, straw yield. Salinity stress affect positively on protein contents in grain of all wheat genotypes and
SARC-7 and SARC-5 performed better than SARC-1 and SARC-8.

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Muhammad Nadeem et al.: Salinity Affects Nutritional Quality of Wheat

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