International Journal of Agricultural Technology 2014 Vol. 10(6):1443-1456
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Effect of Halo (Kcl) Priming on Seed Germination and Early Seedling Growth of Wheat Genotypes under Laboratory Conditions

Solang, S. B. [1], Chachar, Q. I.[1*], Chachar, S. D.[2] and Chachar, N. A.[1]

[1]Department of Crop Physiology, Sindh Agriculture University, Tandojam, [2]Department of Biotechnology, Sindh Agriculture University, Tandojam, Pakistan.

Solang, S. B., Chachar, Q. I., Chachar, S. D. and Chachar, N. A. (2014). Effect of halo (KCl) priming on seed germination and early seedling growth of wheat genotypes under laboratory conditions. International Journal of Agricultural Technology 10(6):1443-1456.

Abstract The study was carried out to evaluate the effect of halo (KCl) priming on seed germination and early seedling growth of wheat genotypes under laboratory conditions during the year 2012, in post graduate laboratory of the Department of Crop Physiology, Faculty of Crop Production, Sindh Agriculture University Tandojam. Five wheat varieties (TD-1, J-83, SKD-1, Imdad-2005 and Moomal-2002) were investigated for their response to different priming treatments of (0, 1.0, 2.0, 3.0 and 4.0 %) of potassium chloride (KCl). The results of experiment regarding varieties revealed that maximum and minimum seed germination (67.68 and 25.14%), root length (3.75 and 1.68 cm), shoot length (2.06 and 1.07 cm), root growth rate (8.67 and 3.33 mm day^{-1}) shoot growth rate (5.06 and 2.60 mm day^{-1}), root fresh weight (246.07 and 163.74 mg $root^{-10}$) shoot fresh weight (196.18 and 165.28 mg $shoot^{-10}$), root dry weight (22.44 and 14.67 mg $root^{-10}$), shoot dry weight (21.76 and 15.26 mg $shoot^{-10}$) root moisture % (88.44 and 77.97 %) and shoot moisture % (88.62 and 79.67 %) in the SKD-1 and TD-1, respectively. It could be concluded that all the growth parameters gave maximum mean value at control and minimum at 4.0 % KCl concentration. Among the varieties, SKD-1 had maximum and TD-1 had minimum mean values for all the parameters studied at different halo priming (KCl) concentrations.

Key words: seed germination, halo (KCl) priming, wheat genotypes

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop in Pakistan and ranks first in the world cereal crops production. It is a staple food of 1/3rd of the world's population and a principal source of carbohydrates and nutrition both for human being and animals. In Sindh wheat is planted on 1092.3 thousand hectares with production of 3703.0 tons and 3390.00 kg/ha yield. (Anonymous, 2010). Wheat is cultivated on the largest acreages in almost every part of the country, it contributes 14.4 percent to the value added in agriculture

* **Corresponding author:** Chachar, Q. I**; e-mail:** qdchachar@yahoo.com

and 3.0 percent to GDP (Go, 2008). Most of the wheat seed used for wheat cultivation is non-certified, stored by farmers from their previous crop resulting in poor yields. Pre-sowing seed treatments seems to be a promising technique to raise successful crop in arid and semiarid tropics. Seed priming enhances speed and uniformity of germination (Khalil *et al.*, 2010 and Khan *et al.*, 2008). Seed priming is defined as pre-sowing treatments in water or in an osmotic solution that allows seed to imbibe water to proceed to the first stage of germination, but prevents radical protrusion through the seed coat. The most important priming treatments are halo priming and hydro priming. Halo priming is a pre-sowing soaking of seeds in salt solutions, which enhances germination and seedling emergence uniformly under adverse environmental conditions. Hydro priming involved soaking of seed in water before sowing.

Potassium chloride (KCl) is the most widely used source of potassium (K) for agricultural crops, and chloride (Cl) is considered an essential micronutrient for optimal growth (Fixen, 1993). Potassium chloride has been introduced as the osmoticum to enhance germination, emergence and growth of Poaceae plants (Misra and Dwivedi, 1980). The objective of this work was to determine if KCl could be a useful nutrient primer for safe seed germination in wheat crop under control conditions. Previous work suggested that the adverse and depressive effects of salinity and water stress on germination can be alleviated by various seed priming treatments. Although the effects of priming treatments on germination of some seed crops has been studied, but relatively little information is available on the invigorating of wheat seed under salt stress. This study was conducted to evaluate the effect different priming methods on seed germination and early seedling growth.

Material and methods

This research work was conducted in the Postgraduate Research laboratory of the Department of Crop Physiology, Faculty of Crop Production, Sindh Agriculture University Tandojam, Pakistan, during the year 2012. The experiment was laid down in Complete Randomize Design (CRD) with three replicates and five treatments (control (no priming), 1, 2, 3, and 4% KCl). Five wheat varieties (TD-1, TJ-83, SKD-1, Imdad-2005, and Moomal-2002) were tested in this work.

Healthy seeds were surface sterilized for 10 minutes with 5% sodium hypochlorite (NaOCl) and were thoroughly washed with distilled water then the seeds were halo (KCl) primed for 24 hours. The Petri dishes were covered with double layered blotting paper. After 24 hours thirty soaked seeds of each wheat variety were placed in Petri dishes. The Petri dishes were moistened with 7 ml of distilled water and placed in the incubator at 25^0C under laboratory condition for up to 5 days. The experimental details are as given below:

The germination percentage, the root and shoot length and their growth rate were observed after 120 hours. The root and shoot length of each treatment were recorded in centimeters. At the end of experiment, roots and shoots were cut separately and weighed for their fresh weight. The shoot and root dry weight of the plant was recorded in milligrams after drying in hot air oven (SANYO, Model, MOV-202, Japan) at $65\,^oC \pm 5\,^oC$ for 72 hours. The root and shoot relative water content was calculated in percentage from fresh and dry weights data.

All the data collected was subjected to analysis of variance (ANOVA) to discriminate the superiority of treatment means and least significant difference (LSD) test was applied, following the methods of Gomez and Gomez (1984) to compare the means. For this purpose a Microsoft computer package "MSTATC" was used.

Results and discussion

The study was carried out to see the effect of halo (KCl) priming on seed germination and early seedling growth of wheat genotypes under laboratory conditions during the year 2012, in post graduate laboratory of the Department of Crop Physiology, Faculty of Crop Production, Sindh Agriculture University Tandojam. Five wheat varieties (TD-1, J-83, SKD-1, Imdad-2005 and Moomal-2002) were investigated for their response to different concentration (0, 1.0, 2.0, 3.0 and 4.0 %) of potassium chloride (KCl). The observations were recorded on seed germination, root and shoot length, growth rate, fresh and dry weight and relative water content.

Seed germination (%)

Data revealed that the mean seed germination percentage of all varieties decrease with increase in treatment levels (Fig. 1). The maximum seed germination was recorded in control (59.75%), followed by (54.71 and 49.67%) in 1.0 and 2.0 % KCl, respectively. The lowest seed germination (46.10 and 44.10%) was recorded when KCl level increased to 3.0 and 4.0 %, respectively. The seed germination percentage in the present study indicated that SKD-1 and Imdad-2005 responded significantly better having maximum seed germination (67.68 and 64.74 %) respectively, at all halo priming levels. The germination percentage of all varieties decreased with increased in treatment levels. The above results are supported by the findings of Afzal *et al.* (2008), Yari *et al.* (2010) and Abbasdokht *et al.* (2011).

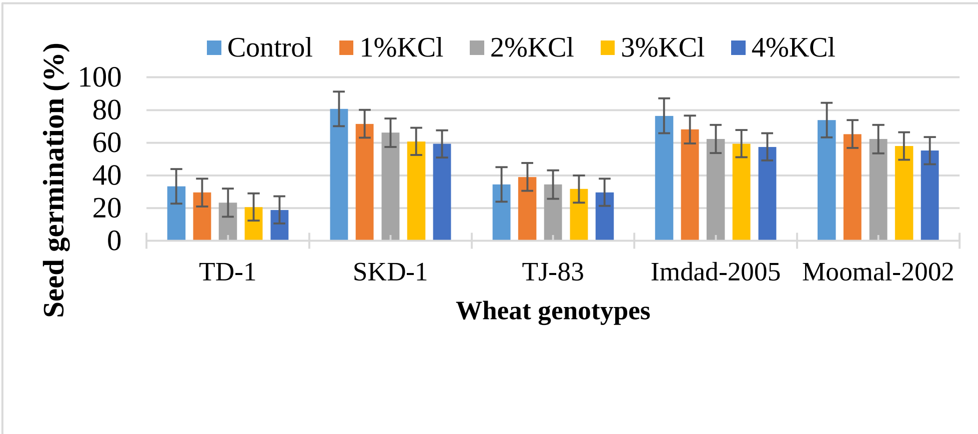

Fig. 1. Effect of halo priming on seed germination (%) of wheat

Root length (cm)

Root length of all wheat varieties decreased significantly with increased KCl levels (Fig. 2). The maximum root length was recorded in control (3.45 cm) followed by (2.93 and 2.58 cm) in 1.0 % and 2.0 % KCl, respectively. The lowest root length of (2.47 and 2.34 cm) was recorded when KCl level increased to 3.0 and 4.0 %, respectively.

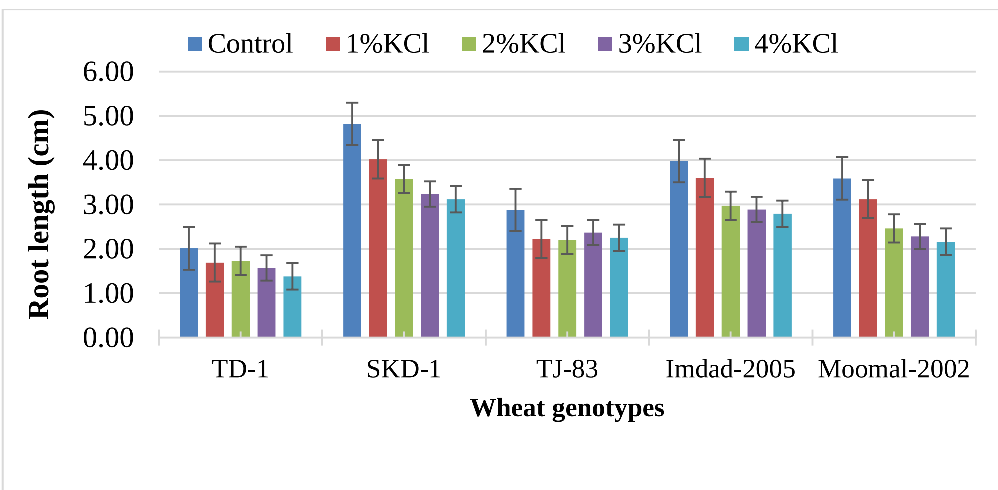

Fig. 2. Effect of halo priming on root length (cm) of wheat

The data regarding root length in the present study showed that the highest root length at various concentration of KCl was recorded in SKD-1 and Imdad-2005 (3.75 and 3.24 cm) respectively, while the minimum root length (1.68 cm) was recorded in TD-1. The varieties SKD-1 and Imdad-2005 responded highly significant for their performance at different KCl concentration. Kaya and Arif (2003), Basra and Afzal (2005) and Amjad *et al.* (2007) concluded that different KCl concentrations had a significant effect on root length.

Shoot length (cm)

Shoot length of all wheat varieties decreased significantly with increased KCl levels (Fig. 3). The maximum mean shoot length was recorded in control (1.78 cm) followed by (1.59 and 1.46 cm) in 1.0 % and 2.0 % KCl, respectively. The lowest mean shoot length of (1.38 and 1.26 cm) was recorded when KCl level increased to 3.0 and 4.0 %, respectively. Maximum shoot length was recorded in SKD-1 (2.06 cm) than Imdad-2005, TD-1, TJ-83 and Moomal-2002 (Fig. 3). The shoot length of all the varieties were decreases with increased in KCl concentrations. Basra and Afzal (2005) suggested that the response of different KCl concentrations had a highly significant effect on shoot length; while Shafi *et al.* (2006) reported that salinity (KCl) had significant effect on shoot length.

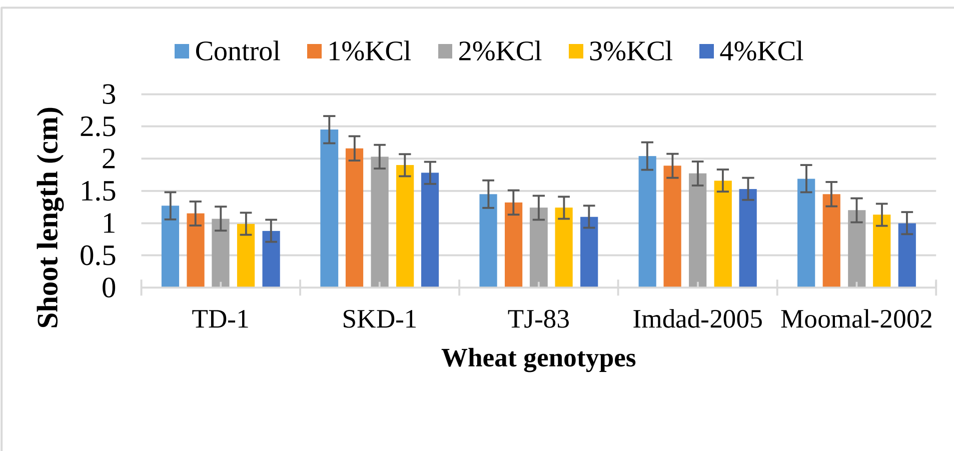

Fig. 3. Effect of halo priming on shoot length (cm) of wheat

Root growth rate (mm day^{-1})

The results indicated that root growth rate of all the varieties was decreased with increased KCl levels (Fig. 4). The maximum mean root growth rate was recorded in control (6.99 mm day^{-1}), followed by (6.74 and 6.25 mm day^{-1}) in 1.0 and 2.0 % KCl, respectively. The lowest mean root growth rate (6.00 and 5.80 mm day^{-1}) was recorded in 3.0 and 4.0 % KCl levels, respectively.

In the present study the maximum root growth rate was witnessed in variety SKD-1 showing (8.67 mm day^{-1}). Almost root growth rate all the varieties shown significantly decreased with increasing different KCl concentrations. The decreasing rate of root growth rate was also reported by other researchers (Basra *et al.*, 2005; Shafi *et al.*, 2006; Iqbal and Ashraf, 2007 and Sayar *et al.*, 2010). They reported that shoot growth rate significantly deceased in response to the increasing KCl level.

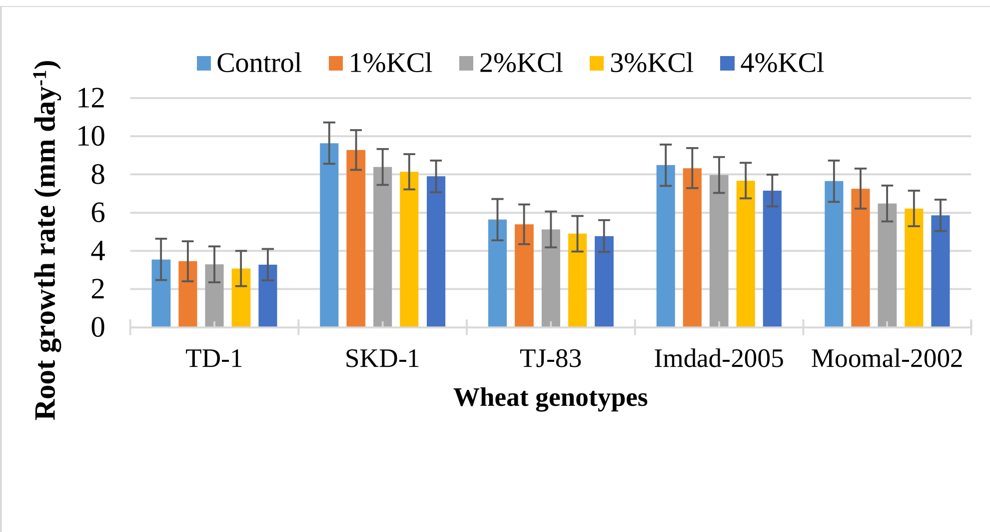

Fig. 4. Effect of halo priming on root growth rate (mm day^{-1}) of wheat

Shoot growth rate (mm/day^{-1})

The results indicated that shoot growth rate of all the wheat varieties was decreased with increased KCl levels (Fig. 5). The maximum mean shoot growth rate was recorded in control (4.24 mm day^{-1}), followed by (4.08 and 3.85 mm day^{-1}) in 1.0 and 2.0 % KCl, respectively. The lowest mean shoot growth rate (3.71 and 3.50 mm day^{-1}) was recorded at 3.0 and 4.0 % KCl level, respectively.

The results regarding the varietal effect on shoot growth rate indicated that SKD-1 and Imdad-2005 responded significantly better with having maximum shoot growth rate (5.06 and 4.57 mm day^{-1}) than Moomal-2002, TJ-83 and TD-1 (4.17, 2.96 and 2.60 mm day^{-1}), respectively.

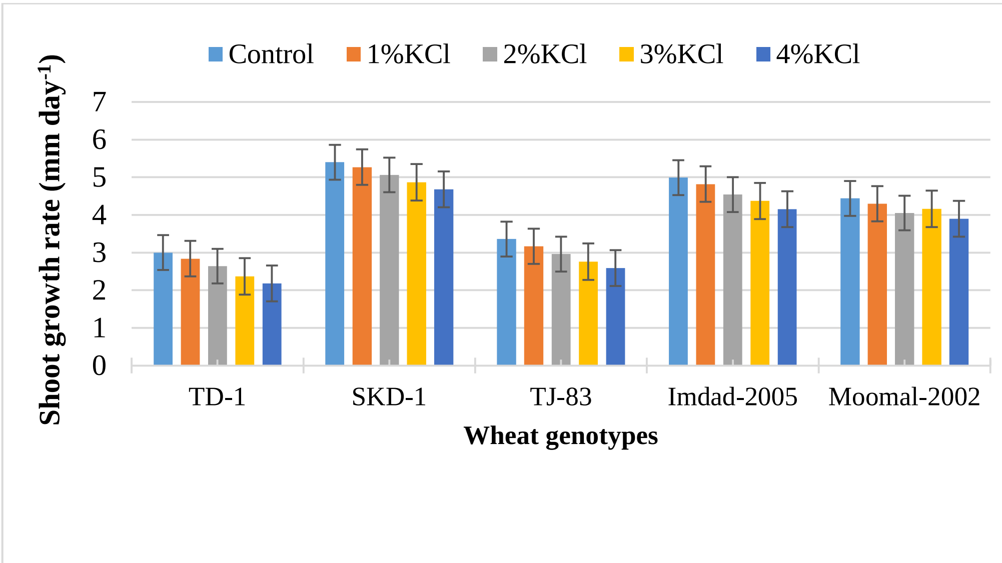

Fig. 5. Effect of halo priming on shoot growth rate (mm day^{-1}) of wheat

In the present study the maximum shoot growth rate was observed in variety SKD-1 (5.06 mm day^{-1}). Almost all the varieties were shown significantly decreased shoot growth rate with increasing KCl concentrations. The decreasing rate of shoot growth rate was also reported by Al-Ansari (2003), Giri and Schillinger (2003), Rafiq *et al.* (2006), Saboora *et al.* (2006) and Shafi *et al.* (2006). They reported that shoot growth rate was significantly deceased in response to the increasing level of KCl.

Root fresh weight (mg root^{-10})

The results shows that maximum root fresh weight was recorded in control (247.4 mg root^{-10}), followed by (227.02 and 210.16 mg root^{-10}) in 1.0 and 2.0 % KCl, respectively (Fig. 6). The lowest root fresh weight (195.09 and 177.18 mg root^{-10}) was recorded at 3.0 and 4.0 % KCl levels, respectively. The results regarding the varietal effect on root fresh weight indicated that SKD-1 and Imdad-2005 responded significantly better having maximum root fresh weight (246.07 and 232.80 mg root^{-10}) than Moomal-2002, TJ-83 and TD-1 (218.47, 195.77 and 163.74 mg root^{-10}), respectively. The root fresh weight in the present study indicated that the highest root fresh weight was recorded in SKD-1 (246.07 mg root^{-10}), whereas the minimum root fresh weight values (195.77 and 163.74 mg root^{-10}), were observed for TJ-83 and TD-1 respectively. The root fresh weight values were decreases with increased in KCl concentrations. The differences among the varieties as well as treatments were significant. The results are in agreement with those of Basra *et al.* (2005) and Yari *et al.* (2010). They reported that the effect of salts (KCl) significantly reduced root fresh weight.

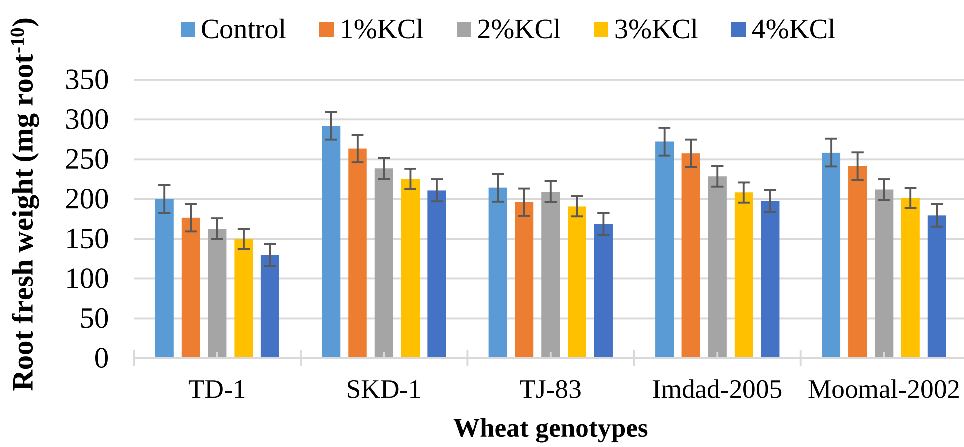

Fig. 6. Effect of halo priming on root fresh weight (mg root^{-10}) of wheat

Shoot fresh weight (mg shoot^{-10})

The results indicated that shoot fresh weight of all the varieties was decreased with increased KCl levels (Fig. 7). The maximum shoot fresh weight was recorded in control (213.25 mg shoot^{-10}), followed by (199.96 and 175.28 mg shoot^{-10}) in 1.0 and 2.0 % KCl, respectively. The lowest shoot fresh weight (157.31 and 139.50 mg shoot^{-10}) was observed at 3.0 and 4.0 % KCl level, respectively.

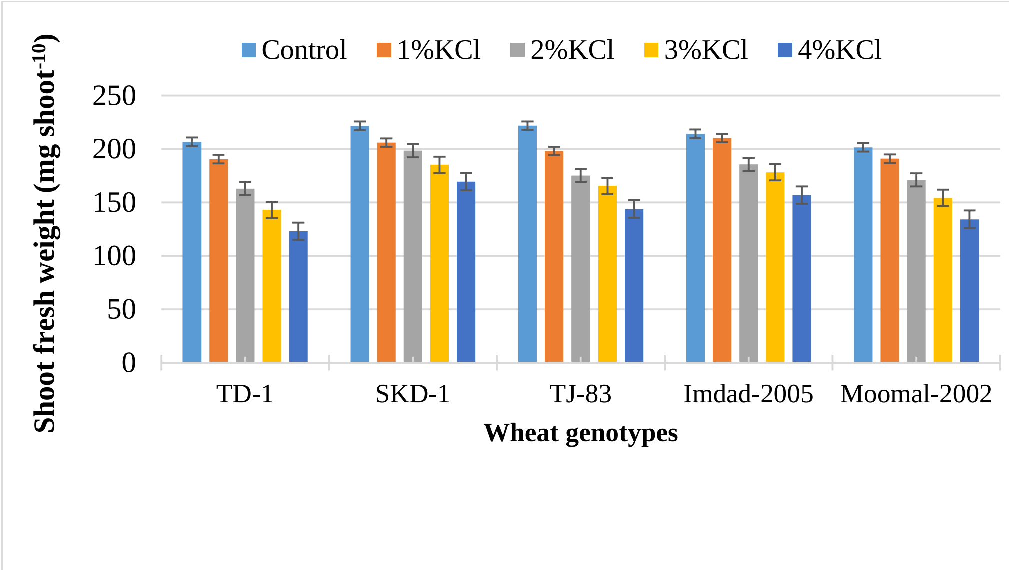

Fig. 7. Effect of halo priming on shoot fresh weight (mg shoot^{-10}) of wheat

The shoot fresh weight in the present study indicated that the highest shoot fresh weight was recorded in SKD-1 (196.18 mg shoot^{-10}) than Imdad, TD-1, TJ-83 and Moomal. The shoot fresh weight values were decreases with increased KCl concentrations. The differences among the varieties as well as treatments were significant. The results are in agreement with those of Basra *et al.* (2005) and Yari *et al.* (2010). They reported that the effect of salt (KCl) significantly reduced shoot fresh weight.

Root dry weight (mg root^{-10})

It was observed from the data that root dry weight of all the varieties was decreased progressively with increased KCl levels (Fig. 8). The maximum root dry weight was recorded in control (21.50 mg root^{-10}), followed by (20.51 and 19.31 mg root^{-10}) in 1.0 and 2.0 % KCl, respectively. The lowest root dry weight (17.90 and 16.49 mg root^{-10}) at 3.0 and 4.0 % KCl level respectively was observed. The results for root dry weight in the present study observed that all the varieties responded quite fairly with various treatment levels, the differences among treatments and varieties were highly significant regarding root dry weight. The variety SKD-1 had maximum root dry weight (22.44 mg root^{-10}). The decrease in root dry weight was also reported by other researchers (Basra *et al.*, 2005; Argentel *et al.*, 2006; Saboora *et al.*, 2006 and Sahfi *et al.*, 2006). They were of the opinion that the treatment level had a significant effect on root dry weight.

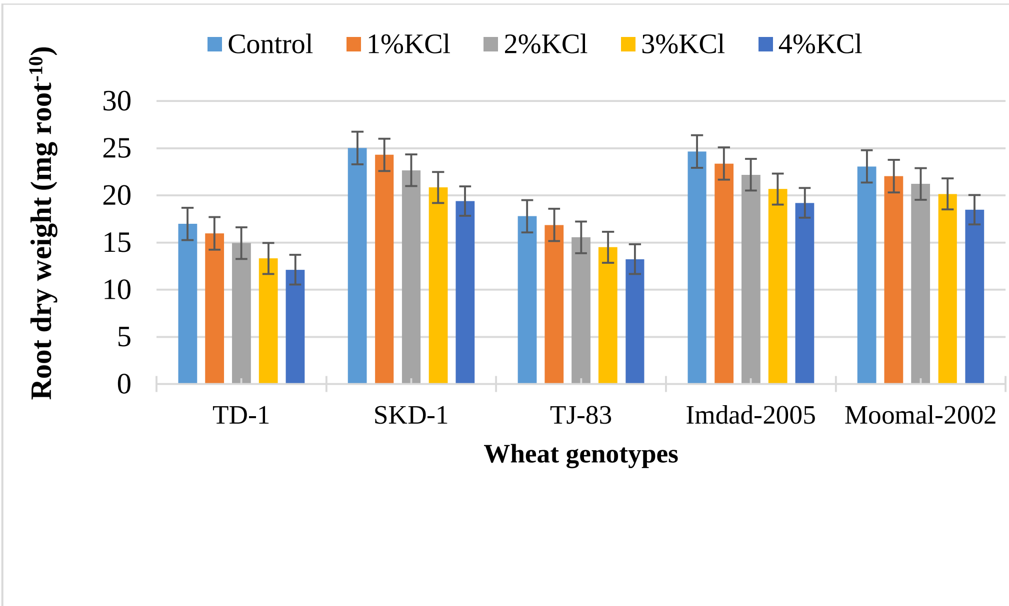

Fig. 8. Effect of halo priming on root dry weight (mg root^{-10}) of wheat

Shoot dry weight (mg shoot^{-10})

The maximum shoot dry weight was recorded in control (20.88 mg shoot^{-10}), followed by (19.79 and 18.48 mg shoot^{-10}) at 1.0 and 2.0 % KCl, respectively (Fig. 9). The lowest shoot dry weight (17.32 and 15.98 mg shoot^{-10}) was recorded when KCl level increased to 3.0 and 4.0 %, respectively.

The results for shoot dry weight in the present study revealed that all the varieties responded quite fairly with various treatment levels and the differences among treatments and varieties were highly significant. The variety SKD-1 had maximum shoot dry weight (21.76 mg shoot^{-10}) at the various treatment levels. The decrease in shoot dry weight was also reported by other researchers (Giri and Schillinger, 2003; Basra *et al.,* 2005; Argentel *et al.*, 2006 and Sahfi *et al.*, 2006). They studied that the treatment levels had a significant effect on shoot dry weight.

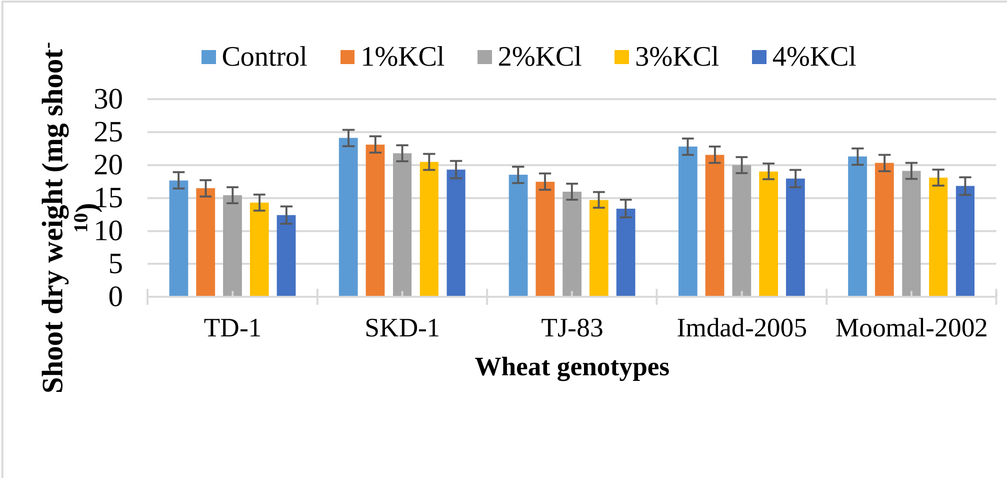

Fig. 9. Effect of halo priming on shoot dry weight (mg shoot^{-10}) of wheat

Root moisture content (%)

The data revealed that root moisture content (%) of all the wheat varieties were decreased progressively with increased KCl levels (Fig. 10). The maximum root moisture content (%) was recorded in control (87.81%) followed by (84.26 and 82.80%) in 1.0 and 2.0 % KCl, respectively. The lowest root moisture content (82.19 and 80.80%) was recorded at 3.0 and 4.0 % KCl levels, respectively. The results regarding the varietal effect on root moisture content indicated that SKD-1 and Imdad-2005 responded significantly better with maximum root moisture (88.44 and 86.33%) than Moomal-2002, TJ-83 and TD-1 (85.94, 80.10 and 77.97%), respectively.

The Root moisture content percentage of all the varieties decreased significantly with increase in treatment levels. The maximum root moisture content was recorded in SKD-1 and Imdad (88.44 and 86.33 %) respectively, while the minimum root moisture content percentage was recorded in variety TD-1. The above result supported by the findings of Shafi *et al.* (2006), they investigated that the KCl level had a significant effect on root moisture content percentage.

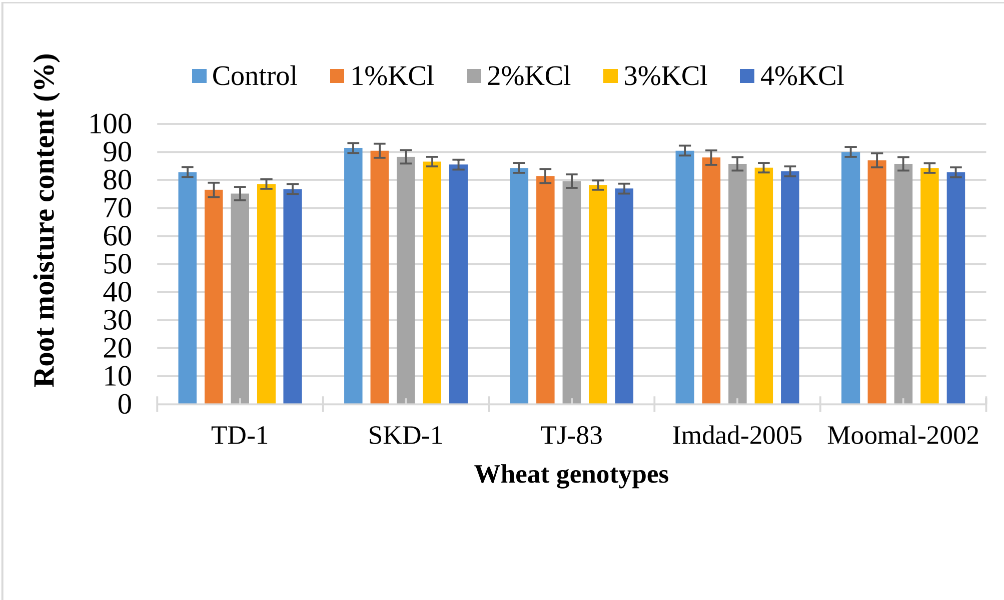

Fig. 10. Effect of halo priming on root moisture content (%) of wheat

Shoot moisture content (%)

The maximum shoot moisture content (%) was recorded in control (86.76%), followed by (85.94 and 84.64%) in 1.0 and 2.0 % KCl, respectively (Fig. 11). The lowest shoot moisture content (83.29 and 82.06%) was recorded when KCl levels increased to 3.0 and 4.0 %, respectively.

The shoot moisture content percentage of all the varieties decreased significantly with increased in treatment levels. The maximum shoot moisture content was recorded in SKD-1 and Imdad (88.62 and 88.60 %), while the minimum shoot moisture content percentage was recorded in variety TD-1. The above result supported by the findings of Eivazi (2011) and Shafi *et al.* (2006) they reported that KCl level had a significant effect on shoot moisture content percentage.

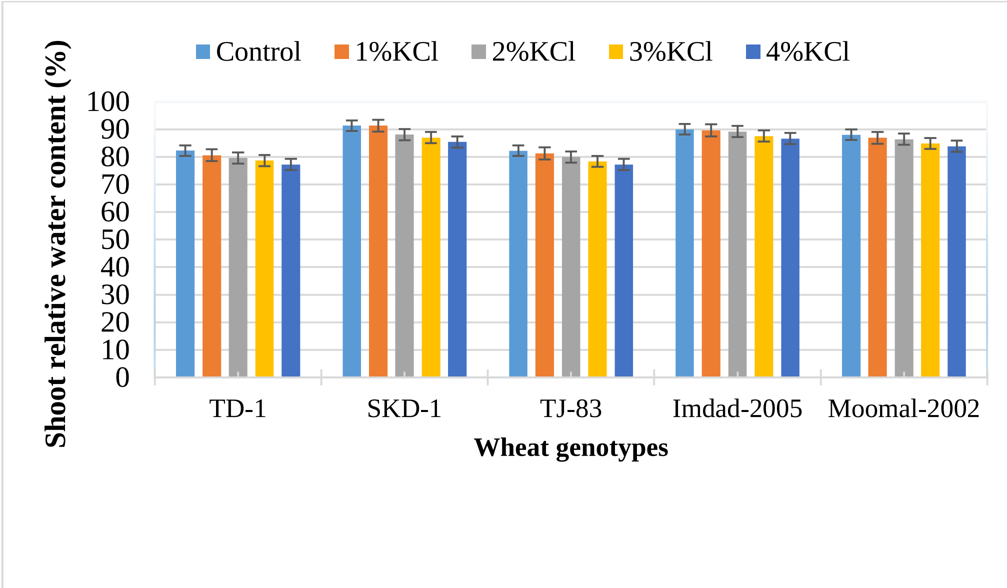

Fig. 11. Effect of halo priming on shoot relative water content (%) of wheat

Conclusion

It could be concluded from present data that varieties, treatments and their interaction were highly significant for germination percentage, root and shoot length, root and shoot growth rate, root and shoot fresh and dry weight and root and shoot moisture content. Among the treatments level all the growth parameters were decrease by increasing the halo priming (KCl) concentrations. Among the varieties, SKD-1 recorded highest mean values, while TD-1 showed minimum mean values for all the parameters at different halo priming (KCl) concentrations.

References

Abbasdokht, H. (2011). The effect of hydropriming and halopriming on germination and early growth stage of wheat (*Triticum aestivum* L.). DESERT 16:61-68.

Afzal, I., Rauf, S., Basra, S. M. A. and Murtaza, G. (2008). Halopriming improves vigor, metabolism of reserves and ionic contents in wheat seedlings under salt stress. Plant, Soil and Environment 54:382–388.

Amjad, M., Ziaf, K., Iqbal, Q., Riaz, M. A. and Saqib, Z. A. (2007). Effect of seed priming on seed vigour and salt tolerance in hot pepper. Pakistan Journal of Agricultural Sciences 44:408-414.

Anonymous. (2010). Crop Reporting Wing of Agriculture Extension. Government of Sindh.

Argentel, L., González, L. M. and Plana, R. (2006). Response of 12 wheat varieties to salinity at the early growth stages. Cultivos Tropicales 27:41-44.

Basra, S. M. A. and Afzal, I. (2005). Inducing salt tolerance in wheat by seed vigor enhancement techniques. International Journal of Environment, Agriculture and Biotechnology 2:173-179.

Eivazi, A. (2011). Induction of drought tolerance with seed priming in wheat cultivars (*Triticum aestivum* l.). International Research Journal of Applied and Basic Sciences 2:95-105.

Fixen, P. E. (1993). Crop responses to chloride. Advances in Agronomy. 5:107-150.

Giri, G. G. and Schillinger, W. F. (2003). Seed priming winter wheat for germination, emergence, and yield. Crop Science 43:2135–2141.

Gomez, K. A, Gomez, A. A. (1984). Statistical procedures for agricultural research Second edition. London: John Wiley and sons, Inc. pp. 13-175.

Go, P. (2008). Economic Survey of Pakistan (2007-08), Ministry of Finance, Government of Pakistan, Pakistan.

Iqbal, M. and Ashraf, M. (2007). Seed preconditioning modulates growth, ionic relations, and photosynthetic capacity in adult plants of hexaploid wheat under salt stress. Journal of Plant Nutrition 30:381–396.

Kaya, M. and Arif, D. (2003). Effects of different soil salinity levels on germination and seedling growth of safflower (*Carthamus tinctorius* L.). Turkish Journal of Agriculture and Forestry 27:221-227.

Khalil, S. K., Mexal, J. G., Rehman, A., Khan, A. Z., Wahab, S., Zubair, M., Khalil, I. H. and Mohammad, F. (2010). Soybean mother plant exposure to temperature stress and its effect on germination under osmotic stress. Pakistan Journal of Botany 42:213-225.

Khan, M. J., Bakht, J., Khalil, I.A., Shafi, M. and Ibrar, M. (2008). Response of various wheat genotypes to salinity stress sown under different locations. Sarhad Journal of Agriculture 24:28-35.

Misra, N. M. and Dwivedi, D. P. (1980). Effects of pre-sowing seed treatments on growth and dry-matter accumulation of high yielding wheat under rain-fed conditions. Indian Journal of Agronomy 25:230-234.

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

Saboora, A., Kiarostami, K., Behroozbayati, F. and Hajihashemi, S. (2006). Salinity (NaCl) tolerance of wheat genotypes at germination and early seedling growth. Pakistan Journal of Biological Sciences 9:2009-2021.

Sayar, R., Bchini, H., Mosbahi M. and Ezzine, M. (2010). Effects of salt and drought stresses on germination, emergence and seedling growth of Durum wheat (*Triticum durum* Desf.). Agricultural Research 5:2008-2016.

Shafi, M., Tariq, M., Akbar, H., Bakht, J. and Rehman, M. (2006). Response of wheat varieties to different levels of salinity at early growth stage. Sarhad Journal of Agriculture 22:585-589.

Yari, L., Aghaalikani, M. and Khazaei, F. (2010). Effect of seed priming duration and temperature on seed germination behavior of bread wheat (*Triticum aestivum* L.). Journal of Agricultural and Biological Science 5:1-6.

(Received 22 September 2014, Accepted 30 October 2014)