CELL MEMBRANE STABILITY AND K/NA MITIGATING ADVERSE EFFECTS OF SALINITY IN VARIOUS WHEAT (*TRITICUM AESTIVUM* L.) VARIETIES

Javed Hussain Umrani[1], Asif Ali Kaleri[2*], Bina Khanzada[3], Atta-U-Rehman[1], Saqib Ali Siddiqui[1], Maqbool Ahmed[4], Mansoor Ahmed[5], Jaffar Hussain[6], Muhammad Haroon[7] and Habibullah Kakar[8]

[1]*Department of Crop Physiology, Faculty of Crop Production, Sindh Agriculture University Tandojam.*
[2]*Department of Agronomy, Faculty of Crop Production, Sindh Agriculture University Tandojam .*
[3]*Agriculture Research Institute, Plant Protection Government of Sindh, Pakistan*
[4]*Department: Directorate Agriculture Research Cereal Crops , Agriculture Research Institute Sariab Road Quetta, Balochistan, Pakistan.*
[5]*Department: Directorate Agriculture Research Water Management & HEIS Agriculture Research Institute Sariab Road Quetta, Balochistan, Pakistan.*
[6]*Department Agronomy, University of Agriculture, Faisalabad Pakistan.*
[7]*Directorate Agriculture Research Cereal Crops , Agriculture Research Institute Sariab Road Quetta, Balochistan, Pakistan.*
[8]*Horticulturist Department: Directorate Agriculture Research Loralai, Balochistan, Pakistan.*
*Email:asifalikaleri2013@gmail.com

ABSTRACT

Salinity is one of the major cause affecting crop growth and productivity. This study was conducted to explore wheat (*Triticum aestivum* L.) varieties for salinity tolerance and yield on the basis of physiological mechanism in the Department of Crop Physiology, Faculty of Crop Production, Sindh Agriculture University, Tandojam. The experiment was arranged in randomized complete design factorial with three replications. Five wheat varieties viz; Sarsabz, Kiran-95, T.D-1, T.J-83 and Moomal were selected for experimentation to evaluate salinity tolerance of different wheat varieties against four salinity (NaCl) levels of 0, 4, 8 and 12 dS m^{-1} using 1/4th strength Hoagland nutrient solution. Plants were grown up to maturity and various physiological parameters were analyzed. The leaves of Sarsabz, Moomal and Kiran-95 varieties showed superior K/Na ratio on 12 dS m^{-1} which is an indication that these varieties are salinity resistant compared to other varieties. T.J-83 and Kiran-95 varieties produced better yield at the highest salinity 12 dS m^{-1} level. The interactive results showed that the maximum index 1000 grain weight (52.20 g) was recorded at interaction of Moomal x control (non-treated). Varieties like Sarsabz, Moomal and T.J-83 showed tolerance by improved cell membrane stability and more accumulation of K+ over Na+ in the cytoplasm.

Keywords: Physiology, salinity, variety, wheat, yield.

INTRODUCTION

Increasing population and growing food demand is creating a serious challenge to a modern agriculture. By the year 2025, the Global food requirements would increase at least by 38% and up to 50% by the year 2050 to combat the dietary requirements of the world due to overwhelming population. It is rarely possible or desirable that food production in extensive areas can be done with the cultivation of mostly suitable lands of the world. Therefore, more human resources are needed to increase the production per unit area. Likewise, decline in nutrition produce shortage of high salt contents in soil and rising tropical intervals temperature has been perceived in recent years. Knowledge on plant responses to abiotic stresses is lacking which is necessary to formulate efficient strategies for improvement in agricultural production (El-Bassiouny and Bekheta 2001). Excessive potassium and sodium levels are favorable for various species than balancing small ratio of sodium which gives logic that sodium toxicity exist for competing binding sites for potassium (Cuin *et al*., 2003) and (Kaleri *et al*., 2024 a). The higher K/Na ratio indicates less Na+ toxicity. Some authors reported that K+/Na+ ratio decreases under salt stress (El-Bassiouny and Bekheta 2001). High salinity of 15 dS m^{-1} reduces the yield components like grain weight plant-1, increase in Na+ and decrease in K+ concentration and K+: Na+ ratio in wheat grain (Abbas *et al*., 2013) and (Ahmed *et al*., 2023). Wheat grain yield is positively correlated with K+ and total soluble salts (TSS) and it is negative correlated with Na+ contents under salinity for physiological traits. Ion accumulation, growth and average grain yield decreases under high salinity of 120mM NaCl (Khan *et al*., 2013; Rehmani *et al*., 2025 and Kaleri *et al*., 2024 b). The various reports were also presented by Akram *et al*. (2002). Salinity reduced 1000 grain yield $plant^{-1}$ (Asgari *et al*., 2012). The aim of the present study was to investigate best varieties on the basis of cell membrane stability and K+/Na+ obtained different wheat verities for grain yield from a pot experiment.

MATERIALS AND METHODS

The commercially grown five high yielding wheat varieties were grown under the wire house condition as well as with four salinity levels 0, 4, 8 & 12 dS m^{-1} by using sodium chloride (NaCl) salt. The experimental design was Completely Randomized Design (CRD) arranged in three replications. Five varieties viz., TD-1, TJ-83, Moomal, Sarsabz and Kiran-95 were examined. The measurement of cell membrane stability was recorded by using polyethylene glycol (Premachandra and Shimada, 1987). Soluble cations including Na+ and K+ were determined from soil samples. Sodium and potassium were determined by Flame Photometer (PFP-7, Jenway, England). 1000 grains were taken and weighed in grams (g) using electronic balance. The data was statistically analyzed using analysis of variance (ANOVA) as factorial design was done by using Statistix Version 8.1.

RESULTS AND DISCUSSION

Figure 1 demonstrates the improved condition of cell walls. Variety Kiran-95 was closely behind T.J-83 in terms of superiority over the others. The modifications revealed that the worst cell wall balance was only at sarsabz*4 dS/m^{-1} and the best one was 3.0 with TJ-83 x 12 dS m^{-1}. additionally, this study showed that the percentage of damage to the cell membrane in various kinds was: T.J-83 (35, 11) and T.D-1 (83, 19, and 23%). The kinds Sarsabz, T.J-83, and Moomal can adapt to these alterations quite well, but Kiran may be overly susceptible to many units that cause the salt measurements to fluctuate in comparison to regular ones. The strongest (14.2%) relationship was found at 25 dS m^{-1}, which may be due to a combination of factors including excessive Na+ damaging cells that absorbed more potassium and sodium. The quantity of grains produced as a result is altered (Shafqat and Azam, 2006; Naqeebullah *et al*., 2024). As stated by Ashraf and Foolad (2005). The amount of salt in the membrane matters. Overabundance of these minuscule, charged "ions" in cells might lead to an imbalance. This then causes something negative to happen when they are under extreme pressure. The integrity of wheat's cell membrane has been utilised as a gauge for the grain's capacity to withstand salt (Sairam *et al*., 2005) and (Kubar *et al*., 2025 a). The T.J-83 type functions better than Mehran-89, Abadgar-93, SKD-1 Imdad -2005, or An while preserving these cell layers.

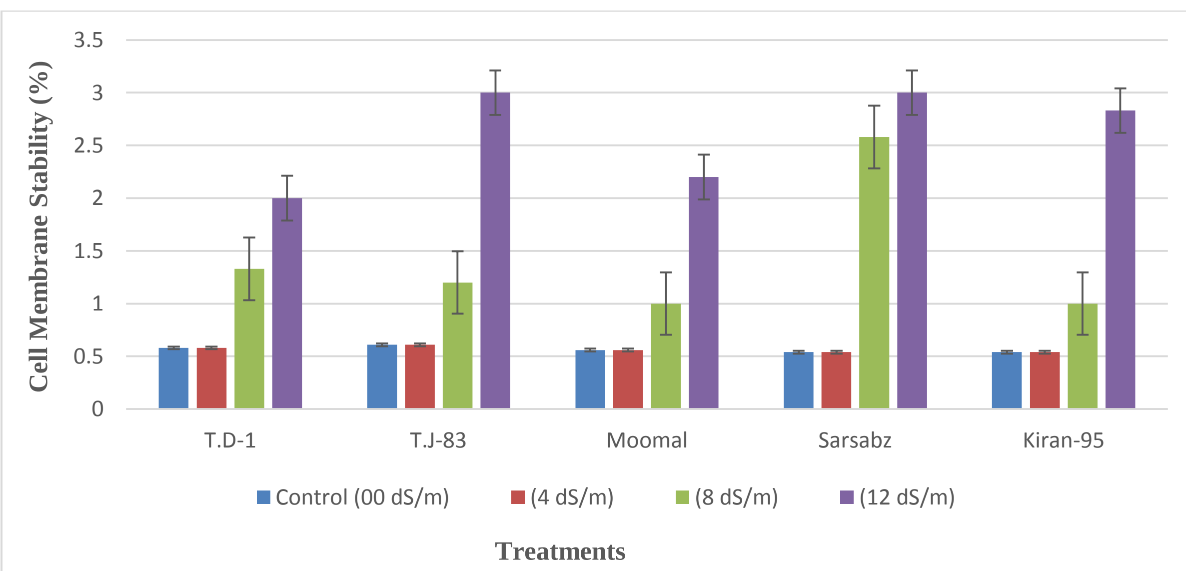

Fig. 1. Salinity's impact on wheat's cell membrane stability.
Salinity, Varieties, Salinity X Varieties: SE = ~0.62~0.70 ~1.40 LSD 5% = 1.27~1.42 ~2.84

The response values in Figure 2 were large. The Moomal and Sarsabz kinds of wheat straw had the highest K+ to Na+ ratios (97.91 & 30; +, respectively); the Kiran-95 variety had the lowest value over two decimals at./.

Additionally, was said that TD's first plant Wheat straw tested with a low reading of just 39 in the control (untreated) group, but it had the highest K+/Na+ rate of 127.67 at Moomal and level one, according to the data. These numerical values correspond to these characteristics as tested on various cultivars. The plants were given low-quality water, with an EC of 12.00 dS m^{-1}. They also ingested roughly the same amount of N, P, and K+ (106.4 mg for every 100 grammes of plant matter, respectively), along with some Na+. While T.J-83, Kiran-95, and T.D-1 performed poorly at 12 dS m^-^ in comparison to the control group, Moomal and Sarsabz performed exceptionally well. Over time, the potassium content of several wheat varieties declined as salt levels increased (Khan *et al*., 2010).Reasonable K+/Na+ noted in little millet (*Panicum colonum* L.) on 120 mM of CaCl2 (Umrani *et al*., 2023) and (Shar *et al*., 2025).

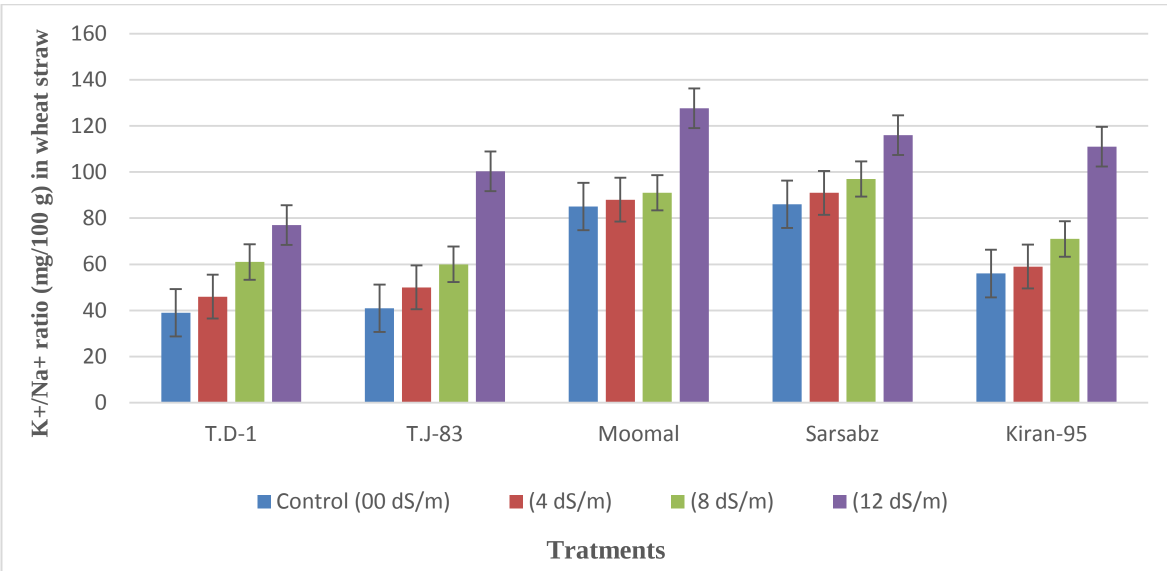

Fig. 2. Effect of salinity on K+/Na+ ratio (mg 100 g-1) in wheat straw**.**
Salinity, Varieties, Salinity X Varieties LSD 5% = 1.21~1.42~2.85 SE = 0.68~0.76~1.52

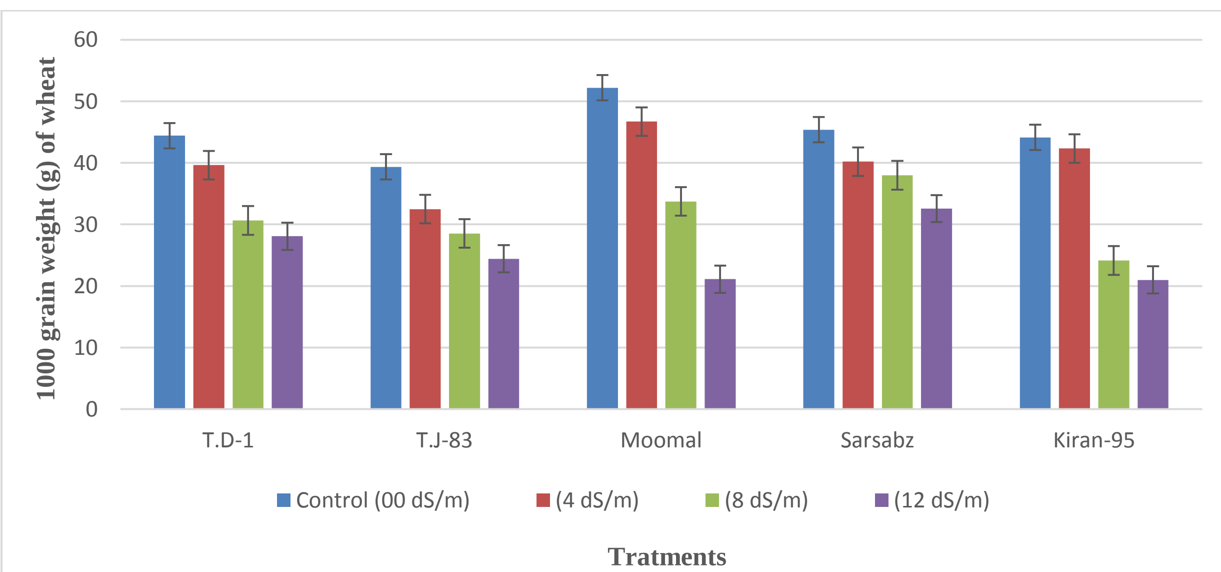

Fig. 3. Salinity's impact on the seed index and the 1000 grain weight (g) of wheat.
Salinity, Varieties, Salinity X Varieties = 0.38 0.42 0.85 LSD 5% = 0.77~0.86~1.73

Figure 3 demonstrates that Sarsabz, with a score of 39, weighs more seeds (1000 grains), followed by TJ-83 and Moomal at. Kiran-95, which received a score of only out of a potential point for this measurement, had the fewest seeds. The outcomes additionally demonstrated the robust reactivity of type TD-1. This team completed a test. When Moomal and control were combined, the highest result (1000 grains weighed) was 52.2, while the lowest result (again for 1 kg of grain) occurred with the Kiran-95 variety at level of dS m^{-1}, primarily in last place. Moreover, 1000 grain size decreased as root area salinity increased. However, the effects varied depending on the kind of wheat crop. It might result from the negative consequences of Na+ in bodily components that are active. It could also occur as a result of ineffective Na+ storage by the cells inside a vacuole (Yeo and Flowers, 1986). On the concentration of12 dSm^{-1}salinity stress, the T.J.-83 and Kiran-95 cultivars demonstrated satisfactory yield (Umrani *et al*., 2024; Gadahi *et al*., 2024 and Kubar *et al*., 2025).

CONCLUSIONS

We can conclude that salinity is a major issue impeding agricultural productivity in Pakistan's arid and semi-arid areas. At 12 dS m^{-1} in salinity levels, vegetables of the Sarsabz, Moomal, and T.J-83 types exhibited more stable cell membranes and greater potassium storage under salt stress compared to Kiran-95 or T.D-1 crops. Moreover, physical characteristics and chemical makeup are found to choose strong and weak types.

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REFERENCES

Abbas, G., M. Saqib, Q. Rafique, A. U. Rahman, J. Akhtar and M. A. Haq (2013). Effect of salinity on grain yield and grain quality of wheat (*Triticum aestivum* L.). *Pakistan J. of Agric. Sci.,* 50 (2): 185-189.

Ahmed, S., A. A. Kaleri, D. Manzoor, G. M. Khushk, M. H. Solangi, W. A. Khaskheli, A. R. Gadahi, R. Laghari and N. F. Pathan (2023). Effect of different irrigation water regimes on water productivity of wheat crops. *Pure and Applied Biology*, 12(3): 1479-1489.

Akram, M., S. Akhtar, I. H. Javed, A. Wahid and E.V. Rasul (2002). Anatomical attributes of different wheat (*Triticum aestivum* L.) accessions/varieties to NaCl salinity. *Int. J. Agri. Biol.,* 4: 166-168.

Asgari, H. R., W. Cornelis and D. P. Van (2012). Salt stress effect on wheat (*Triticum aestivum* L.) growth and leaf ion concentrations. *Intern. J. of Plant Production,* 6(2): 195-208.

Ashraf, M. and M. R. Foolad (2005). Pre-sowing seed treatment-a shotgun approach to improve germination, plant growth, and crop yield under saline and non-saline conditions. *Adv. Agron.,* 88:223-271.

Cuin, T. A., A. J. Miller, S. A. Laurie and R. A. Leigh (2003). Potassium activities in cell compartments of salt grown barley leaves. *J.Exp.Bot.,* 54: 657-661.

El-Bassiouny, H. M. S. and M. A. (2001). Bekheta. Role of putrescine on growth, regulation of stomatal aperture, ionic contents and yield by two wheat cultivars under salinity stress. *E. J. Physiol. Sci.,* 2-3: 239-258.

Haroun, S. A. (2002). Fenugreek growth and metabolism in response to gibberellic acid and sea water. *Assuit Univ., J. Bot.,* 31: 11-12.

Gadahi, R, A., M. G. Laghari, A. A. Kaleri, D. Manzoor, A. Afzal, R. A. Mahar, A. Jan, S. Khan, A.M. Soomro, S. Ullah, A. A. Sodhro and A, A. Kaleri (2024).Effect of different weed management practices on growth and yield of wheat (*Triticum aestivum* L.). *Pure and Applied Biology*,14(2): 297-303.

Kaleri, A, A., M. M. Lund, D. Manzoor, U. Z. Din, M. Faizan, A. Azhar, H. T. Shah, S. Solangi, K. K. Bukhsh, A. W. Rajput and S. G. Kaleri (2024a). Comprehensive Evaluation of the Various Effects of Fertilization With Potassium, Zinc, and Boron on Wheat Growth and Yield Performance. *International Journal of Biology and Biotechnology*, 21(4): 597-603.

Kaleri, A, A., N. B. Mangan, H. M. Awan, M. G. Banbhan, N. Maryam, A. F. Kaleri, D. Manzoor, A. Jamali, M. Hameed, M. Sadiq and S. Adil (2024b). Evaluating the Varied Effects of Micronutrients on Wheat Variety TJ-83 Cultivation in Tando Jam. *Society of Life Sciences*, 8(2): 217.

Kausar, A and M. Gull (2014). Nutrients uptake and growth analysis of four sorghum (*Sorghum bicolor* L.) genotypes exposed to salt stress. *Pensee J.* 76 (4).

Khan, M. A., M. U. Shirazi, M. Ali, S. Mumtaz, A. Sherin and M. Y. Ashraf (2006).Comparative Performance of Some Wheat Genotypes Growing Under Saline Water. *Pak. J. Bot.,* 38 (5): 1633-1639.

Khan, A. M., E. Islam, M. U. Shirazi, S. Mumtaz and S. M. Mujtaba (2010). Physiological response of various wheat genotypes to salinity. *Pak. J. of Bot*., 42: 3497-3505.

Kubar, S, M., A. A. Kaleri, D. Manzoor, U. Rehmani, A. Gull, A. Khan, M. W. Jiskani, M. M. Wahocho, A. G. Buriro, H. S. Mirbahar, A. Kaleri and Y. Wude (2025a). Grain Yield of Winter Wheat Associated with Agronomical and Physiological Characteristics. *Journal of Asian Development Studies*, 14(1): 117-128.

Kubar, S, M., A. A. Kaleri, D. Manzoor, U. Rehmani, U. S. Rehman, W. Baksh, H. Munir, R. Laghari, R. V. Meghwar, K. L. M. Bazai and Y. Wude (2025b). Impact Of Nitrogen Fertilizer Management on Distribution of Nitrogen Content in Different Organs of Winter Wheat. *Kashf Journal of Multidisciplinary Research*, 2(1): 45-58.

Premachandra, G. and T. Shimada (1987). The measurement of cell membrane stability using polyethylene glycol as a drought tolerance test in wheat. *Jpn. J. Crop Sci.*, 56, 92–98.

Naqeebullah, D. Manzoor, A. A. Kaleri, K. Kakar, A. Sadiqa, M. Islam, A. Musawwir, Z. Ullah, A. Jamali, M. Sadiq and S. Adil (2024). Effects of Phosphorus Application Rate on the Growth and Yield of Wheat (*Triticum aestivum* L.). *Pak-Euro Journal of Medical and Life Sciences*, 7(2): 151-158.

Rehmani, U., D. Manzoor, R. Jalal, M. M. Khan, K. A. M. Mansoor, I. Shah, M. Hamzeh, H. A. Mastoi, H. S. Shar and M. Ali (2025). Potassium Quantification for Wheat (Triticum Aestivum L.) under the Agroecological Conditions of District Swabi. *Journal of Agriculture and Biology*, 3(1): 125-130.

Sairam, R. K., G. C. Srivastava, S. Agarwal and R. C. Meena. 2005. Differences in antioxidant activity in response to salinity stress in tolerant and susceptible wheat genotypes. *Biol. Plant.*, 49: 85-91.

Shafqat, F. and F. Azam. 2006. The use of cell membrane stability (CMS) technique to screen for salt tolerant wheat varieties. *J. Plant. Physiol.*, 163 (6): 629-637. (2006).

Shar, A, P., A. A. Soomro, A. A., Kaleri, D. F. Soomro, N. Naz, Zarnaz, H. K. Jamali, H. A. Mastoi, Y. M. Tahir and H. S. Mirbahar (2025). Characterizing Drought Tolerance in Wheat Genotypes for Yield Associated Traits Under Different Water Stress Conditions. *Journal of Agriculture and Biology*, 3(1): 219-230.

Umrani,J H., A. A. Kaleri, D. Manzoor, N. A. Buriro, S. Z. Khan, H. Munir, W. M. Jiskani, S. Fazal, U. Rehmani and L. Ashfaq (2024). Performance of various wheat (Triticumaestivum L.) cultivars under salinity stress. *J. Life Sci, LGU.*, 8 (04). 5537-550.

Umrani, J. H.**,** K. H. Talpur and S. R. Ali (2023).Physiological approach through cell sap for chloride stress tolerance and ion content in little millet (*Panicum colonium* L.). *Pak. J. Sci. Res. Ser. B: Bio. Sci.*, 66 B (3) 255-260.

Yeo, A. R and T. J. Flowers (1986). Ion relations of plants under drought and salinity. *Austral J. Plant Physiol.*, 13: 75-91.

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