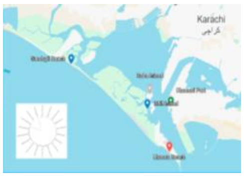

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Performance of Various Wheat (*Triticum aestivum* L.) Cultivars under Salinity Stress

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ABSTRACT: *Salinity is an abiotic stress limiting the physiological mechanisms, growth and yield in wheat. The aim of this research was to evaluate various wheat verities under different salinity stresses. The data was collected for the study using a CRD design with three replications. For the pot experiment, five different wheat types were chosen: Sarsabz, Kiran-95, T.D.-1, T.J.-83, and Moomal to find out the tolerant cultivar under four different salinity (NaCl) levels viz; 0, 4, 8, and 12 dSm^{-1}.The results further suggested that cultivar Sarsabz shows higher levels of proline (12.12 µmol g^{-1}) and glycine betaine (14.18 µmol g^{-1})when compared to the control. Furthermore, at 12 dSm^{-1}, the K^+/Na^+ ratio was higher in Sarsabz, Moomal, and Kiran-95, indicating that these cultivars were more salinity-tolerant than the others. The T.J.-83 and Kiran-95 cultivars demonstrated enhanced yield at the maximum salinity threshold of 12 dSm^{-1}. Findings from the interaction between Moomal and control (non-treated) led to the highest 1000grain weight (52.1g). The Sarsabz, Moomal, and T.J.-83 strains showed tolerance by having higher amounts of proline, glycine-betaine and cell membrane stability. Such concentration of proline, glycine-betaineand sufficient concentrations of K^+ over Na^+ in the cytoplasm can lead the plants for tolerance.*

Keywords: Cultivar; Physiological traits; Salinity; Wheat; Yield

INTRODUCTION

Modern agriculture is facing enormous challenges from a growing population and an increasing need for food. Worldwide food needs are expected to increase by at least 38% by 2025 and by as much as 50% by 2050 in response to the nutritional demands of a growing global population. Cultivating the best land available worldwide alone is not enough to meet the ever-growing demand for food. Research shows that due to the increase in tropical temperatures, causing salinity stress finally creating food shortage. It is difficult to develop practical methods to increase agricultural productivity without a thorough understanding of how plants react to abiotic stressors (Lyuben et al., 2014). Abiotic stressors cause low crop yields in modern agriculture, which presents serious issues (Kosova et al., 2013; Kausar and Gull, 2014). Many plants commonly build up proline during osmotic control in response to salinity toxicity, acting as a defense against salt damage (Wang et al., 2007). Accumulation of prolinein plants and serves as osmoregulation and an important tool for selection of salinity tolerant cultivar (Haroun, 2002; Ueda et al., 2007). Solutes like proline, glycine, betaine, and polyols build up in the cytoplasm, which helps keep the vacuole's water potential and balance Dos Reis et al., (2012). Cui et al. (2003) found that proline is essential for maintaining protein stability at the cellular and membrane levels, especially in situations where osmotic stress is elevated. Different species prefer high potassium and low sodium ratios, suggesting that the competition between potassium and sodium for binding sites leads to sodium toxicity. A greater K^+/Na^+ ratio indicates reduced sodium toxicity. Several writers (Gadallah, 1999; Haroun, 2002) have documented a reduction in the K^+/Na^+ratio under salt stress. Increased Na+ concentration decreased K^+ concentration, and decreased K^+/Na^+ratio in wheat grain are the outcomes of elevated salinity at 15 dSm^{-1}. According to Abbas et al. (2013), elevated salinity also affects other yield components such as the number of tillers per plant and grain weight per plant. There is a positive relationship between wheat grain yield and K^+, proline, and total soluble salts (TSS). On the other hand, there is a negative relationship between physiological characteristics and Na^+ concentrations when the soil is salty. According to Mehboob et al. (2017) high salinity specifically at 120 mMNaCl reduces ion buildup, overall growth and average grain production. Hussain et al. (2015) and Rehman et al. (2016) suggested that salt stress reduces mineral nutrients, grain production, and gas exchange activities in wheat. Furthermore, Asgari et al. (2012) and Akram et al. (2002) documented a decrease in the number of spikelets per spike, the number of grains per spikelet and the 1000 grain weight per plant due to salinity. This research was conducted to examine suitable wheat cultivars under various salinity stresses.

METHODOLOGY

The seeds of high yielding wheat varieties were grown under the wire house conditions as well as four 0, 4, 8, and 12 dS/m were maintained by using (NaCl) salt. The experiment was Completely Randomized Design (CRD) arranged in three replications. Five wheat varieties viz; Kiran-95, TD-1, TJ-83, Moomal, and Sarsabz were examined.

Studied Parameters

Proline (µmol g^{-1})

One-gram fresh leaf samples were homogenized in 100 ml 3% sulfosalicylic acid and filtered. Filtrate 2ml separated, 2 ml ninhydrin solution and 2ml glaicial acetic acid added. Heated on water bath at 100°C and cool. Toluene 4ml added and placed in vertex for 30 seconds and readings noted at 520 nm on spectrophotometer by using the method of Bates et al. (1973).

Glycine-betaine (µmol g^{-1}): 0.01 g fresh leaves homogenized with 2N sulfuric acid and centrifuged at 12000×g (25°C) for 25 minutes. The residue crystals diluted in acetone and absorbance noted on spectrophotometer at 365 nmGrieve and Gratan (1983).

Cell Membrane Stability (%): Chopped leaf samples placed in distilled water at room temp for 24 hours. Electrical conductivity (EC) was noted by using EC meter (WTW, LA-530). Then placed in water bath for 15 minutes at 100°C, allowed to cool at room temperature and again EC was recorded by using EC meter.

Grain Yield [1000 grain weight (g)]:

Manually threshed main spike of wheat to take 1000 grains and then weighed in grams (g) using electronic balance.

Potassium and Sodium(mg 100 g^{-1}): Fresh ground leaf shoots were treated with 0.2 mm acetic acid (CH_3 COOH) in a water bath for 1 hour per-heated at 95°C. The extracted solution was filtered to make suitable for dilution Na^+ and K^+ and concentrations were checked on flame photometer (Jennay, Model PFP7) by using the method of Flowers and Yeo (1986).

STATISTICAL ANALYSIS

The experiment was conducted in complete randomization design (CRD) and repeated thrice. Treatments means were compared by Least Significant Difference (LSD) test at 0.05 probability level (Steel and Torrie 1984).

RESULTS AND DISCUSSION

Proline Content (μmol g^{-1}) in Leaves of Wheat under Various Salinity Stresses.

The maximum amount of proline (14.74) in wheat leaves was determined at high salinity stage12 dSm^{-1}followed by (8.66) and (6.31) at 8 and 4 dSm^{-1} and the lower proline (5.09 µmol g^{-1}) was observed on control, respectively. The mean of varietal performance was significant, the more proline content (12.12) in variety Sarsabz followed by (10.60) in Moomal and the lowest proline (6.81 and 6.69 **µ**mol g^{-1}) values were recorded in TD-1 and Kiran-95 cultivars, although the variety T.J-83 also exhibited significant response. The interactive results indicated that the higher concentration of proline (22.87) was recorded at interaction of Sarsabz x 12 dSm^{-1} whereas the lower concentration of proline (4.95 **µ**mol g^{-1}) was observed in same variety Sarsabz x control (non-treated), respectively. This is achieved by minimizing the concentrated of salt management rise inside of solute recently acknowledge as survival strategy to salts stress in various crops (Khan et al., 2010; Ashraf and Sarwar, 2002) and proline is a major constituent in salinity tolerance mechanism (Qasim et al., 2003). The proline ratio is varied depending upon the varieties. In stress circumstances proline is a common organic osmolyte (Khan et al., 2006). Highest accumulation of proline in Sarsabz, Moomal and T.J-83 under salinity stress resembling with the observations have been recorded by (Qasim et al., 2003), an increase in proline under salinity stress in *Pancratiumm aritimum* L. Similarly (Ashraf and O’Leary, 2004) also reported an increase in proline accumulation in various grass species under salinity stresses.

Table 1: Proline Content (µmol g^{-1}) in Leaves of Wheat under Various Salinity Stresses

Salinity levels (dSm^{-1})	Varieties					Mean
	T.D-1	**T.J-83**	**Moomal**	**Sarsabz**	**Kiran-95**	
Control	5.07 kl	5.20 jkl	5.17 jkl	4.95 l	5.08 kl	5.09 d
4	5.61 i-l	5.91 h-k	6.57 gh	7.83 f	5.65 i-l	6.31 c
8	6.25 ghi	7.00 fg	11.16 d	12.83 d	6.05 hij	8.66 b
12	10.30de	11.07 d	19.49 b	22.87 a	9.98 e	14.74 a
Mean	6.81 d	7.29 c	10.60 b	12.12 a	6.69 d	

SE = 0.10 0.12 0.24

LSD 5% = 0.22 0.24 0.29

Glycine-betaine (µmolg^{-1}) in Leaves of Wheat under Various Salinity Stresses

The various concentrations of Glycine-betaine were obtained as highest**,** moderate and lowest (22.86, 10.75, 7.22 and 6.14 µmol g^{-1}) when plants were treated with 12, 8,4 and control treatments, respectively. Significantly higher glycine-betaine content (14.18) in the cultivar of Sarsabz, Secondly, Moomal cultivar shows superior amount of glycine-betaine(12.19), thirdly, T.D-1 possess greater assets of glycine-betaine (11.25µmol g^{-1}). While the lowest glycine-betaine contents 10.55 and 10.54 recorded in TJ-83 and Kiran-95 cultivars, respectively. The interaction outcome indicated that under control conditions the lowest glycine-betaine(5.64 µmol g^{-1}) was noted in Kiran-95 cultivar. Although, on 12 dSm^{-1} the Sarsabz cultivar obtained highest glycine-betaine (28.58 µmol g^{-1}**)**. Sarsabz and Moomal varieties showed higher glycine-betaine content than the control, T.D-1, T.J-83, and Kiran-95 cultivars at the highest salinity level of 12dSm^{-1}. According to Sairam et al. (2002), the amount of glycine-betaine was much lower in the varieties that were vulnerable, while the amounts were higher in the tolerant varieties in both the saline and control conditions. The response of both Sarsabz and Moomal cultivars was observed to have a higher increase in glycine-betaine accumulation, thereby making them tolerant cultivars. There are dissimilarities in accumulation of glycine-betainein various wheat cultivars when screened on 100 mmol L^{-1}NaCl salt stress. However, salinity tolerant wheat cultivar showed superior glycine-betaine content (Khan et al. 2012).

Table 2: Glycine-betaine (µmolg^{-1}) in Leaves of Wheat under Various Salinity Stresses

Salinity levels (dSm^{-1})	Varieties					Mean
	T.D-1	T.J-83	Moomal	Sarsabz	Kiran-95	
Control	6.95 ghi	5.74 i	5.96 i	6.42 hi	5.64 i	6.14 d
4	8.16 g	6.48 hi	6.81 ghi	7.91 gh	6.73 ghi	7.22 c
8	11.48 f	7.83 gh	10.00 f	13.81 e	10.63 f	10.75 b
12	18.40 d	22.17 c	26.00 b	28.58 a	19.16 d	22.86 a
Mean	11.25 c	10.55 d	12.19 b	14.18 a	10.54 d	

SE =	**0.17**	**0.19**	**0.39**
LSD 5% =	**0.36**	**0.40**	**0.80**

Cell Membrane Stability (%) in Leaves of Wheat under Various Salinity Stresses

According to the results of cell membrane stability of different wheat varieties under different salinity levels. The lowest and highest cell membrane stability (0.57, 0.570and 32.46 %) recorded on the control 4 and 12 dSm^{-1} treatments, while on the treatment of 8dSm^{-1}the level of cell membrane stability was (4.18%). Accordingly, the T.J.-83 variety had the highest cell membrane stability of 11.80 %, followed by the Kiran-95 variety with 10.35%. The mean values for the various varieties showed a significant response. The Sarsabz variety had the lowest stability (6.16%). Conferring to the results of interaction, T.J-83 and 12 dSm^{-1} had the highest cell membrane stability (40.00%), while the interaction between Sarsabz and 4 dSm^{-1} was the lowest (0.540%). Furthermore, how stable the cell membranes are in low-quality water under 12 dSm^{-1} considering the various wheat cultivars viz; T.D-1 (83%, 194%, and 238%), TJ-83 (35%, 112%, and 135%), Moomal (127%, 173%, and 220%), Sarsabz (31%, 100%, and 156%), and Kiran-95 (68%, 121%, and 163%). Variations Kiran-95 and T.D-1 were deemed significantly susceptible up to 12 dSm^{-1} compared to the control, while variations Sarsabz, Sarsabz and Moomal showed tolerance. Similar results were found by Shafqat and Azam (2006), with the greatest injury percentage (74.2%) at 25 dSm^{-1}, possibly due to the combined effects of Na^{+}

toxicity and cellular injury mediated by Na^+ and K^+ absorption. Ashraf et al. (2005) claim that high salt concentrations affect membrane stability by generating an improper ionic cell balance. Cell membrane vitality, a reliable standard assessment, has determined the degree of salt tolerance (Meloni et al., 2003; Sairam et al., 2005). According to Umrani et al. (2013), the wheat varieties T.J.-83 had better recovery of cell membrane stability and lower conductivity than the wheat varieties Mehran-89, Abadgar-93, SKD-1, Imdad-2005 and Anmol-91.

Table 3: Cell Membrane Stability (%) in Leaves of Wheat under Various Salinity Stresses

Salinity levels (dSm^{-1})	**Varieties**					**Mean**
	T.D-1	**T.J-83**	**Moomal**	**Sarsabz**	**Kiran-95**	
Control	**0.583 g**	**0.617 g**	**0.567 g**	**0.540 g**	**0.543 g**	**0.570 c**
4	0.583 g	0.617 g	0.567 g	0.540 g	0.543 g	0.570 c
8	4.333 ef	6.000 e	4.000 ef	2.583 fg	4.000 ef	4.183 b
12	35.000 b	40.000 a	30.000 c	21.000 d	36.333 b	32.467 a
Mean	10.125 bc	11.808 a	8.783 c	6.166 d	10.355 b	

SE = 0.62 0.70 1.40

LSD 5%= 1.27 1.42 2.84

K^+/Na^+(mg 100 g^{-1}) in Wheat under Various Salinity Stresses

The table no. 4 summarized the maximum level of K^+/Na^+ ratio (106.40mg 100 g^{-1}**)** obtained in the wheat straw when pots were watered with 12 dSm^{-1} higher concentration of NaCl salt, followed by (76.00mg 100 g^{-1}**)** on the treatment of 8 dSm^{-1}, and the lowest K^+/Na^+(61.40mg 100 g^{-1}**)** noted in the control treatment. The Moomal variety and Sarsabz cultivars possessed superior highest K^+/Na^+ratio (97.91 and 97.50 mg 100 g^{-1}**)** in straw, respectively. The T.D-1 variety listed the lowest K^+/Na^+ ratio 55.75 in straw $plant^{-1}$, whereas the Moomal and Sarsabz cultivars exhibited the ratio of 74.25. Furthermore, T.J-83 variety also exhibited a notable response. The interaction between the Moomal variety and 12 dSm^{-1} produced the highest K^+/Na^+ratio (127.67 mg

100 g^{-1}**)** in wheat straw, while the considering the collaboration of T.D-1 cultivar and control (non-treated) having lowest K^+/Na^+ratio (39.00mg 100 g^{-1}**)**. In low water quality the wheat plants obtained (106.40 mg 100 g^{-1}**)** of K^+/Na^+ when electrical conductivity (EC) was 12 dSm^{-1}. When compared to the control, the Moomal and Sarsabz cultivars performed better, but the T.J.-83, Kiran-95and T.D.-1 cultivars showed poor response at 12 dSm^{-1}. Different wheat cultivars showed a progressive decrease in K^+ with increasing saline levels as reported by El-Bassiouny and Bekheta (2001) and Saleh et al. (2015). Similarly, the lowest K^+/Na^+ ratio was recorded in the wheat varieties of Faisalabad and Anaj-17 (0.67 and 0.50) under 10 dS/m NaCl. While the highestK^+/Na^+ratio in leaves was found in Galaxy-13 under treatment of 15 dS/m NaCl suggested by Iqra et al. (2020).

Table 4: K^+/Na^+(mg 100 g^{-1}) in Wheat under Various Salinity Stresses

Salinity levels (dSm^{-1})	**Varieties**					**Mean**
	T.D-1	**T.J-83**	**Moomal**	**Sarsabz**	**Kiran-95**	
Control	39.00 cd	41.00 c	85.00 abc	86.00abc	56.00 b	61.40 d
4	46.00 bc	50.00 bc	88.00 abc	91.00 ab	59.00 b	66.80 c
8	61.00 b	60.00 b	91.00 ab	97.00 ab	71.00 abc	76.00 b
12	77.00 abc	100.33 ab	127.67 a	116.00 a	111.00 a	106.40 a
Mean	55.75 d	62.83 c	97.91 a	97.50 a	74.25 b	

SE =	**0.68**	**0.76**	**1.52**
LSD 5%=	**1.21**	**1.42**	**2.85**

Effect of Salinity on Grain Yield [1000 grain weight (g)] in Various Wheat Cultivars

Result concerning grain yield depicted that highest 1000 grain weight of various cultivars was **(**45.10 g) noted on control treatment, followed by (40.27 g) on treatment 4 dSm^{-1} and the lowest 1000 grain weight **(**25.44 g) weighed on high salinity of 12 dSm^{-1}. In terms of cultivar performance, the Sarsabz cultivar showed the highest grain yield (39.03 g), followed by the T.J-83 (38.70 g) and Moomal cultivars (38.44 g). The mean values for the various varieties showed a significant response. The variety Kiran-95 has the minimum grain yield (32.90 g). Furthermore, the results demonstrated that the T.D-1 cultivar exhibited a reasonable performance. The interaction between cultivars x treatments suggested that the cultivar Kiran-95 x 12 dSm^{-1} had the lowest grain yield (20.99 g) and cultivar Moomal x control (non-treated) had the greatest 1000 grain weight (52.20 g). Additionally, decrease in the 1000 grain weight in response to an increase in root zone salinization, although the impact varied across wheat varieties. Various other findings suggested that 7.00 dSm^{-1} is best for salinity tolerant for wheat crop and limit the 25% yield on 9.00 dSm^{-1}Kramer and Amtmann (2012). Kalhoro et al. (2016) confirmed that on high level of salt stress drastically minimize the yield in 1000 grain weight. The average grain yield of wheat on salinity status of (8 and 12dSm^{-1}) was (12.51 and 11.63g) and reduced7.13 and 13.66%, respectively compared to the control treatment which was (13.47 g) Kreet and Samira (2020).

Table 5: Effect of Salinity on Grain Yield [(1000 grain weight (g)] in Various Wheat Cultivars

Salinity levels (dSm^{-1})	**Varieties**					**Mean**
	T.D-1	**T.J-83**	**Moomal**	**Sarsabz**	**Kiran-95**	
Control	44.42 bc	39.35 ef	52.20 a	45.39 bc	44.14 bcd	45.1 a
4	39.63 ef	32.49 g	46.71 b	40.20 ef	42.33 cde	40.27 b
8	30.66 gh	28.54 j	33.74 gef	37.97 f	24.15 i	31.01 c
12	28.09 h	24.43 k	21.12 g	32.57 g	20.99 ij	25.44 d
Mean	35.70 c	26.70 b	43.44 b	39.03 a	32.90c	

SE = 0.38 0.42 0.85

LSD 5% = 0.77 0.86 1.73

CONCLUSION

In conclusion, brackish water and salinity provide serious obstacles to agricultural output. This is a global issue for arid and semi-arid regions Sindh, Pakistan. Different types of cultivars like Sarsabz, Moomal, and T.J.83 performed better under the status of 12 dSm^{-1} of salinity stress compared toKiran-95 and T.D-1 based on proline, betaine and cell membrane stability as well as more potassium (K^+) than sodium (Na^+) constitute in the tissues. Molecular markers, physiological and biochemical approaches can also improve the selection of both tolerant and sensitive cultivar types.

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