Ecophysiologically Abiotic Stress Tolerance and Nutrition Content in Wheat (*Triticum Aestivum* L.)

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Received: March 24, 2022; Accepted: April 10, 2022; Published: April 17, 2022

ABSTRACT

Salinity is one of the major abiotic stresses affecting crop growth and productivity. This study was conducted to explore different 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

Abiotic stress; Ecophysiology; 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

Citation: Javed Hussain Umrani, Ecophysiologically Abiotic Stress Tolerance and Nutrition Content in Wheat (*Triticum Aestivum* L.). Food Proc Nutr Sci 3(1): 10-14.

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 [1]. 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 [2]. The higher K^+: Na^+ ratio indicates less Na^+ toxicity. Some authors reported that K^+/Na^+ ratio decreases under salt stress [1]. 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 [3]. 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 120 *mM* NaCl [4]. The various reports were also presented by Hasan et al. [5], Sorour et al. [6] who concluded that salinity reduced 1000 grain yield plant$^-$. 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 dS m^{-1}, 4 dS m^{-1}, 8 dS m^{-1} & 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 [7]. 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 Statistics Version 8.1.

RESULTS AND DISCUSSION

The Table 1 shows significantly superior cell membrane stability 1.35 was observed in variety T.J-83 followed by variety Kiran-95 1.22. The interactive results showed that the maximum cell membrane stability 3.00 was recorded at interaction of T.J-83 × 12 dS m^{-1} whereas the minimum cell membrane stability 0.54 was observed at interaction of sarsabz × 4 dS m^{-1}. Furthermore, this study depicted that the cell membrane stability (% injury) in different varieties was: for T.D-1 (83, 19 and 23 %), T.J-83 (35, 11 and 13 %), Moomal (12, 17 and 22 %), Srasabz (11, 10 and 15 %) and Kiran-95 (16, 12 and 16 %) under poor quality of water 12 dS m^{-1}. Varieties Sarsabz, T.J-83 and Moomal showed tolerance whereas; Kiran-95 and T.D-1 may rank as sensitive varieties up to 12 dS m^{-1} as compared to control. Similar findings suggested that highest (14.2 %) at 25 dS m^{-1}, probably due to combined effect of Na^+ toxicity and cellular injury is also affected with the uptake of Na^+ and K^+ and finally affects the grain yield [8]. According to [9] membrane stability is dependent on high level of salts that cause in appropriate balance of ionic cell which leads to form poisonous matter under adverse pressure conditions. In dereference of degree of salt tolerance cell membrane vitality has been utilized as a competent standard judgment [8]. Wheat variety T.J-83 recovers cell membrane stability and possesses higher conductivity than Mehran-89, Abadgar-93, SKD-1, Imdad-2005 and Anmol-91 varieties [10].

Salinity Levels (dS m^{-1})	Varieties					Mean
	T.D-1	T.J-83	Moomal	Sarsabz	Kiran-95	
Control	0.583	0.617	0.567	0.54	0.54	0.57 c
4	0.583	0.617	0.567	0.54	0.54	0.57 c
8	1.333	1.200	1.000	2.58	1.00	1.42 b
12	2.000	3.000	2.200	3.00	2.83	2.60 a
Mean	1.12	1.35	1.08	1.66	1.22	

Table 1: Shows significantly superior cell membrane stability.

	Salinity	Varieties	Salinity X Varieties
SE =	0.62	0.70	1.40
LSD 5% =	1.27	1.42	2.84

The Table 2 described values for significant response, the maximum K^+/Na^+ ratio in wheat straw 97.91 and 97.50 values were recorded in Moomal and Sarsabz varieties followed by 74.25 was observed in recorded in Kiran-95 variety whereas the minimum 55.75K^+/Na^+ ratio straw plant^{-1} was recorded in variety TD-1 variety further results indicated that variety TJ-83 variety also showed significant response. The interactive results showed that the maximum K^+/Na^+ ratio in wheat straw 127.67 was recorded at interaction of Moomal variety × 12 dS m^{-1} whereas the minimum K^+/Na^+ ratio in wheat straw 39.00 was observed TD-1variety x control (non- treated), respectively. Plants received poor quality water EC 12.00 dS m^{-1}, the uptake of N, P, K^+, Na^+, K^+/Na^+ was 106.40, mg 100 g^{-1} respectively. Varieties Moomal and Sarsabz showed better performance while, T.J-83, Kiran-95 and T.D-1 showed poor performance at 12 dS m^{-1} as compared to control. Increasing salinity levels resulted gradual reduction of K^+ in different wheat varieties [1] and [11].

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

Table 2: Effect of salinity on K+/Na+ ratio (mg 100 g-1) in wheat straw.

	Salinity	Varieties	Salinity X Varieties
SE =	0.68	0.76	1.52
LSD 5%=	1.21	1.42	2.85

The Table 3 reveals significantly higher seed index (1000 grain weight, g) 39.03 was recorded in Sarsabz variety followed by 38.70 and 38.44 in TJ-83 and Moomal varieties and the lowest seed index (1000 grain weight, g) 32.90 was observed in Kiran-95 variety. The results further indicated that the variety TD-1 also showed significant response. The interactive results showed that the maximum index (1000 grain weight, g) 52.20 was recorded at interaction of Moomal × control (non-treated) whereas the minimum index (1000 grain weight, g) 20.99 was observed in Kiran-95 variety × 12 dS m^{-1}, respectively. Furthermore, 1000 grain weight showed a reduction with increase in root zone salinization but the effect was varied in different wheat varieties. could be attributed to toxic effects of Na^+ in the physiologically active parts of tissues; it might be due to inefficient compartmentalization of Na^+ in vacuoles [12].

Salinity Levels (dS m^{-1})	Varieties					Mean
	T.D-1	**T.J-83**	**Moomal**	**Sarsabz**	**Kiran-95**	
Control	44.42	39.35	52.20	45.39	44.14	45.1 a
4	39.63	32.49	46.71	40.20	42.33	40.27 b
8	30.66	28.54	33.74	37.97	24.15	31.01 c
12	28.09	24.43	21.12	32.57	20.99	25.44 d
Mean	35.70 c	26.70 b	43.44 b	39.03 a	32.90c	

Table 3. Effect of salinity on seed index (1000 grain weight) (g) of wheat.

	Salinity	**Varieties**	**Salinity X Varieties**
SE =	0.38	0.42	0.85
LSD 5% =	0.77	0.86	1.73

CONCLUSION

It can be concluded that salinity is major factor adversely affecting agricultural production in arid and semi-arid regions of Pakistan. Varieties like Sarsabz, Moomal and T.J-83 showed tolerance by having improved cell membrane stability, more accumulation of potassium over sodium K^+/Na^+ in the tissue contents as compared to Kiran-95 and T.D-1under 12 dS m^{-1} of salinity stress. It is also concluded that physiological and biochemical traits sustain the selection of tolerant and sensitive varieties.

ACKNOWLEDGMENT

This research work fully supported by department of food science and technology, Hamdard University, Karachi.

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