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Study of Nacl Salinity Effect on Wheat (*Triticum aestivum* L.) Cultivars at Germination Stage

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Abstract: Establishment of seedlings at early growth stages of crop plants as one of the most important determinants of high yield is severely affected by soil salinity. Therefore, high germination rate and vigorous early growth under salty soils is preferred.The response of five genotypes of wheat (*Triticum aestivum* L.) to NaCl salinity at germination and early seedling growth was investigated. Salinity treatments (0, -2, -4, -8 and -10 bars) were achieved by adding NaCl in deionized water. There was a decrease in water up take and germination of all cultivars. Increase salt concentration also affected the early seedling growth. Among the cultivars under investigation Seimareh cultivar appeared to be more sensitive at germination stage. However, it performed quite satisfactorily at seedling stage.

Key words: Cultivars · Wheat · Salinity · Germination · Seedling

INTRODUCTION

Abiotic stresses including drought and salinity are currently the major factors which reduce crop productivity world-wide. Excessive amounts of salts in soil severely reduced the seed germination and further seedling growth and this has been well documented [1-5]. This has been ascribed due to salt-induced osmotic stress or due to its toxic effects or combination of both of these [1, 2, 4, 5]. Stalinization is the scourge of intensive agriculture [6]. High concentrations of salts have detrimental effects on germination of seeds [7, 8] and plant growth [9]. Many investigators have reported retardation of germination and growth of seedlings at high salinity [10]. However plant species differ in their sensitivity or tolerance to salts [11]. Wheat is a major staple food crop for more than one third of the world population and is the main staple food of Asia [12]. It is originated in South Western Asia and has been a major agricultural commodity since pre historic times. Total production area in Pakistan is 8.2 mha and the average yield is 2170 kg/ha [13]. Wheat crop is mainly cultivated under rain fed conditions where precipitation is less then 900 mm annually. Wheat is grown both as spring and winter crop. Winter crop is more extensively grown than spring. The possible cause of varietal difference most likely evolves ion transport properties and cellular compartementation [14]. Schachtmann and Munns [15] reported that sodium exclusion was a general characteristic of salt tolerance in wheat lines; where as, salt tolerant display much higher shoot sodium level than sensitive lines. Few studies have been carried out on the relative salt tolerance of various cultivars of agricultural crops of Pakistan [6, 7]. The screening of salt tolerant lines/cultivars has been attempted by many researchers on various species at seedling growth stage [16]. The relation of various seedling growth parameters to seed yield and yield component under saline conditions are important for the development of salt tolerant cultivar for production under saline conditions. The study presented here deals with the response of five cultivars of wheat to NaCl stress at germination and early seedling growth stage.

MATERIAL AND METHODS

This study was carried out with Seeds of five wheat (*Triticum aestivum* L.) genotypes names: MV17, Seimareh, Leucurum, Boeuffi and Cascogne. The grains were surface sterilized by dipping the grains in 1% mercuric chloride solution for 2 minutes and rinsed thoroughly with sterilized distilled water. There were five salinity treatments having osmotic potential 0 (control), -2, -4, -8 and -10 bars. These treatments were prepared by dissolving separately calculated amounts of NaCl in

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deionized water. All the experiments were conducted in 9 cm Petri plate on filter paper beds in growth chambers. 20 grains were sown in 9 cm diameter Petri plate on filter paper beds, irrigated with 5 ml solution of respective treatment and incubated at 25°C. Each treatment was replicated thrice. The filter paper beds were irrigated daily with 5 ml solution of the respective treatment. The filter beds were changed after 48 hours in order to avoid salt accumulation.

Water Uptake: Water uptake was recorded for 12 hours. Water uptake percent was calculated by the formula given below [17]:

$$\text{Water uptake, \%} = \frac{W_2 - W_1}{W_1} \times 100$$

W1 = Initial weight of seed

W2 = Weight of seed after absorbing water in a particular time.

Germination: The emergence of radical/plumule from seed was taken as an index of germination. The germination percent was recorded daily up to 10 days.

Recovery Test: Recovery test was applied on those seeds which did not germinate in the scheduled time. Non-germinated seeds were washed with distilled water and sown in Petri plates on Whatmann's No.1 filter paper in an incubator at 25°C±1 for 7 days. 5.5 mL distilled water was added to each Petri plate daily.

Seedling Growth: After 10 days the seedlings were harvested and the following observations were made:

Root/ Shoot Length

Root/ Shoot Biomass

Salt Tolerance: Salt tolerance was calculated by the formula given below:

$$Salt\ tole\tan ce = \frac{Gen\min ation / Growth\ in\ particular\ treatment}{Gen\min ation / Growth\ in\ control} \times 100$$

Data for germination were subjected to arcsine transformation before analysis of variance. Data ware subjected to statistical analysis using ANOVA, a statistical package available from Spss16.

RESULTS

Water Uptake: Water uptake by grains showed direct relation with increasing salinity of the medium (Fig. 1). At higher osmotic potentials i.e. -8 and -10bars the water uptake decreased as compared with control. The cultivars can be arranged in the following order on the basis of water uptake.

Boeuffi>Mv17>cascogne>Seimareh>Leucurum>Boeuffi

Germination: Salt tolerance at germination stage is important factor, where soil salinity is mostly dominated at surface layer. The increase in salinity not only decreased the germination but also delayed the germination initiation (Fig 2). The initiation of germination of cv. Raskoh was delayed up to one day by all levels of salinity while of cv. seimareh beyond -4bars osmotic potential. The increase in salinity up to -10 bars osmotic potential had no effect on germination of cv. Seimareh grains. The maximum decrease in germination was observed in cv. Leucurum i.e. 69.84%. The cultivars had the following order on basis of germination at-10 osmotic potential.

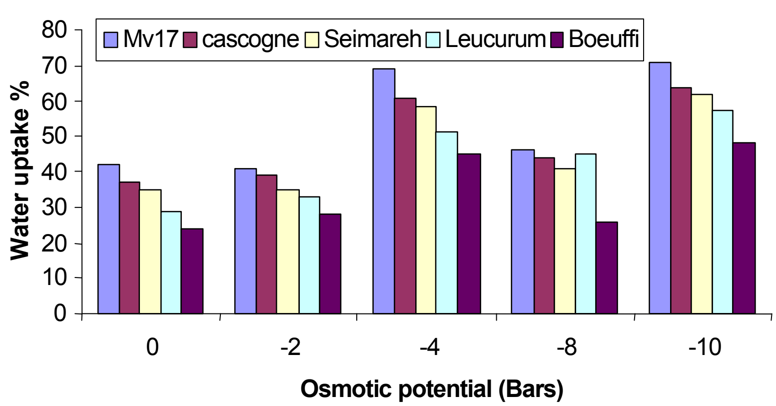

Fig. 1: Effects of NaCl salinity on water up take by grains of wheat (*Triticum aestivum* L.) cultivars

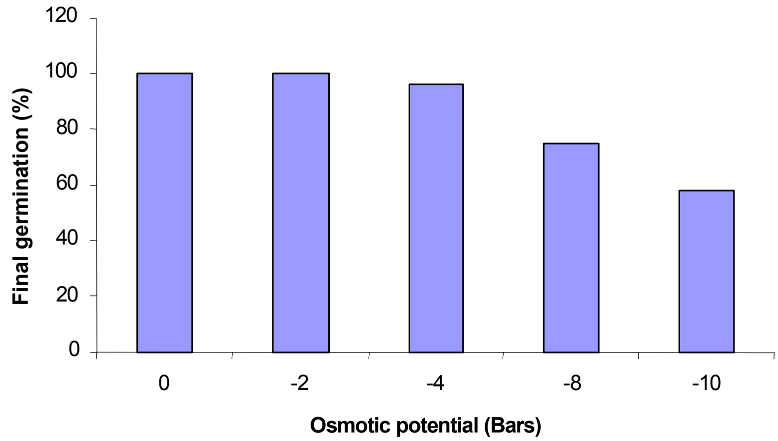

Fig. 2: Germination percentage of wheat grains as influenced by salinity. Values with the same superscript letters are not significantly different at P< 0.05.

Table 1: Recovery of wheat (*Triticum aestivum* L.) cultivars at germination stage

Treatment Osmotic potential (Bars)	Genotypes germination (%) Mv17	Cascogne	Seimareh	Leucurum	Boeuffi
-2	(-)	(-)	(-)	(-)	(-)
-4	(3)0	(2)0	(-)	(1)0	(-)
-8	(7)0	(9)25	(-)	(10)36	(1)0
-10	(11)53	(14)34	(-)	(14)34	(3)0

() No. of non germinated grains sown in each treatment

Table 2: Effects of salinity on salt tolerance index of wheat (*Triticum aestivum* L.) cultivars at germination and seedling growth stage

genotypes	Treatments Mv17		cascogne		Seimareh		Leucurum		Boeuffi	
Osmotic Potential (Bars)	Germination	growth	Germination	growth	Germination	growth	Germination	growth	Germination	growth
-2	100	84.59	100	85.15	100	74.95	100	83.15	100	100
-4	89.13	64.19	94.26	74.52	100	70.25	96.59	71.58	100	80.24
-8	65.74	41.84	57.59	55.16	100	63.14	54.26	59.35	95.14	72.36
-10	41.26	21.26	32.56	41.06	100	35.10	30.15	38.16	87.18	51.27

Leucurum>Cascogne>Mv17>Boeuffi>Seimareh

The results of recovery test applied to the non germinated seed (Table 1) show that the grains of cultivar Mv17 showed up to 53 % recovery at and beyond-10 bars osmotic potential. The non germinated grains in different salinity treatment of other three cultivars i.e. Seimareh and Boeuffi showed no recovery.

Seedling Growth: Seedling growth was recorded in terms of shoot/root length and shoot/root biomass at different levels of NaCl salinity. The increase in NaCl concentrations decreased the shoot and root length and biomass of all the wheat cultivars. All cultivars responded in same manner to salinity stress. However, the intensity of stress varied with the cultivars. It had been observed that those cultivars responded poorly at germination stage showed better response at seedling stage. The reduction in shoot growth was greater than root growth. The reduction in biomass production was also greater in cultivar having higher germination rates. The maximum decrease in root and shoot length at osmotic potential - 10 bars was recorded in cultivar Mv17 which is 83 and 84%, respectively. Salinity had reduced the biomass (weight) in the range of 54 to 87 % in root and 66 to 91% in shoot of different cultivars.

Salt Tolerance: Data regarding salt tolerance of different cultivars under investigation (Table 2) showed that cultivar Seimareh is most tolerant at germination stage, while cultivar Boeuffi at seedling growth stage. On the basis of tolerance at germination and seedling growth stage, the cultivars can be arranged as follows:

Germination: seimareh> Boeuffi> Mv17 >Cascogne> Leucurum

Seedling Growth: Boeuffi > Cascogne > Leucurum > seimareh > Mv17

DISCUSSION

Salinity Affects Germination in Two Ways:

- There may be enough salt in the medium decrease the osmotic potential to such a point which retard or prevent the uptake of water necessary for mobilization of nutrient required for germination (Fig 1).
- The salt constituents or ions may be toxic to the embryo.

Our results are in line with the findings of Kollar [18] and Rahman [8] that germination was directly related to the amount of water absorbed and delay in germination to the salt concentration of the medium. Decrease and delay in germination in saline medium has also been reported by Rahman [8] and Mirza [19]. After application of seeds which did not germinated (Table 1) probably their embryo was damaged due to the presence of Na^+/Cl^- ions.

Physiologically absolute ratio of K^+/Na^+ in the tissue is important. It has been suggested that ion ratios are important in determining relative toxicities of various ions and can provide insight in to ion antagonisms [20]. The increase in salinity shortens this ratio [21] and probably caused injury to embryo. Greater recovery at lower osmotic potentials has been reported by Kayani and Rahman [22]. They suggested that this might be due to low concentration of ions. The salt tolerance of plants varies with the type of salt and osmotic potential of the medium [22]. Water availability is one of the main environmental factor limiting photosynthesis and growth [23]. Salinity affects the seedling growth of plants [24, 25] by slowing or less mobilization of reserve foods [26], suspending the cell division, enlargement [27] and injuring hypocotyls [28]. Our results contradict with Khan and Sheikh [29] that salinity depressed root growth more than shoot growth. Other researchers [30, 31], have demonstrated that plants exhibit different sensitivities to salinity at different stages of growth. Among the varieties tested Leucurum cultivar appeared to be more sensitive at germination stage then others. Although Leucurum cultivar had comparatively low germination at higher salinity levels but performed quiet satisfactorily at seedling stage. Ayers and Hayward [32] reported that there may not be a positive correlation between salt tolerance at germination stage and during later phases of growth as observed in the present studies (Table 2). Many plants are most sensitive to ion stress during germination [33] or young seedling growth [34, 35]. Mahmood and Malik [36] observed greater salt tolerance at growth than germination stage. It is clear from the results that behavior of cultivars varies both at germination and seedling growth stages. This shows that species /varieties can never be selected simply on the basis of higher germination %. According to Mass and Grieve [37] the ability of seed to geminate and emerge in saline soilnot only depends upon the concentration of salts, but also upon various other biological factors i.e. viability of seed, seed age, dormancy, seed coat permeability, internal inhibitors and genetic makeup. While, George and William [37] have the opinion that greater tolerance to salinity during germination is associated with lower respiration rates and greater reserve of respiratory substances.

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