Research Article

Screening of Various Bread Wheat (*Triticum aestivum* L.) Varieties in Different Saline Soils on the Basis of Emergence and Plant Height

Shamsher Ali[1]*, Sarmad Khan[1], Muhammad Jamal Khan[2], Naveed ullah[4], Muhammad Rashid[3] and Wiqar Ahmad[1]

[1]Department of Soil and Environmental Sciences, Amir Muhammad Khan Campus Mardan, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; [2]Department of Soil and Environmental Sciences, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; [3]Research Officer, Agricultural Research System, Khyber Pakhtunkhwa, Pakistan; [4]Department of Water Management, The University of Agriculture, Peshawar Khyber Pakhtunkhwa, Pakistan.

Abstract | An experiment in pots was carried out at Amir Muhammad Khan Campus Mardan, The University of Agriculture to screen out bread wheat varieties in different soils at early growth stage. Five bread wheat varieties i.e Atta Habib, Barsat, Siren, Pirsabak-2004 and Pirsabak-2005 were cultivated under three soils having different salinity levels; i- Normal-non saline soil (EC=0.9 dS m^{-1}), ii- moderately saline soil (EC=7.2 dS m^{-1}) and iii- highly saline soil (EC=13.3 dS m^{-1}). The experiment was arranged in completely randomized design (CRD) with two factors, repeated thrice. Wheat varieties were sown per pot randomly on 15th November, 2014 and grown for 3 weeks after emergence. Plants growth was observed for three weeks after emergence. Statistical analysis of the data showed that both soils and varieties significantly ($p<0.05$) affected per cent emergence and growth. Interactions between soils and varieties were significant ($p <0.05$) regarding emergence and plant heights. From the interactions it is clear that under normal soil conditions, emergence percentage of Pirsabak-2004 variety was maximum (100 %), under moderate soil salinity, emergence percentage of Siren variety was maximum (27 %), while under high salinity, emergence percentage of Atta Habib variety was maximum (30 %). Under highly saline soil, the maximum plant growth i.e 1.03 cm, 1.80 cm and 3.77cm after 1st, 2nd and 3rd week of emergence were recorded by Atta Habib variety, respectively. Atta Habib variety also showed maximum plant growth of 9.93 cm in normal soil after 3rd week of emergence. In moderately and highly salt affected soils, maximum plant height of 3.3 cm and 3.7 cm respectively was produced in Atta Habib variety. Thus it was concluded that Atta Habib variety was more tolerant to salt affected conditions at early growth stage as its emergence percentage and plant height was significantly different from other four varieties.

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***Correspondence** | Shamsher Ali, Department of Soil and Environmental Sciences, Amir Muhammad Khan Campus Mardan, the University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; **Email:** shamsherali@aup.edu.pk
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Introduction

Wheat is mainly grown in arid and semi-arid regions of the world (Iqbal, 2003). It is the major cereal crop used as a staple food by about more than one third of the world's population. Its flour is used for making bread. Wheat is grown all over the world and Pakistan as well. Wheat was grown on more than

9.2Mhaareas in Pakistan. A total production of about 23.5M tonnes along with an average yield of about 2591kg ha^{-1} was reported during 2013-2014(Anon, 2013). In Khyber Pakhtunkhwa (KPK) province of Pakistan, wheat production was about1251462 tonnes along with cultivated area of 680311 ha and average yield of about 1840 Kg ha^{-1} during 2013-14 (Agriculture Statistics, Peshawar, KPK, 2013-14).

Salinity is major ecological factor which mainly interfere the emergence of the young seedling negatively due to toxicity of salts, in which the seeds cannot absorb moisture to germinate. The major problem in saline soil is the emergence of the crop. Emergence and productivity of salt affected soils is reduced due to the sovereignty of soluble salts or exchangeable sodium in it (Akram et al., 2002). Salinity inhibits emergence, plant's growth and yield to appoint that depends upon plant species, salinity level and ionic composition of salts that show role in its growth. Excess of salt accumulation in the root show first effect on emergence and then on growth and development of plants and wheat crop as well (Qayyum et al., 2007). Salinization upsets both irrigated and un-irrigated systems under which wheat is cultivated (Mujeeb-Kazi and Diaz deLeon, 2002). Increase in root zone salinity causes low emergence and decline in plant height and quality of wheat grains (Steppun and Wall, 1997; Turki et al., 2012; Houshmand et al., 2014). In wheat, crop stand and quality of the grain declines under saline conditions (Maas and Grieve, 1990; Maas et al., 1994; Turki et al., 2012; Houshmand et al., 2014).

Apt managing of salt affected soils can increase per acre yield of wheat. In this regard, cultivation of high yielding varieties along with resistance against biotic and abiotic stresses can be sown (Ali et al., 2005). Improving salt tolerance of wheat is important to guarantee food security and sustainable economy (Tahir et al., 2006). Various species of the same plant vary in their response to salt stress conditions (Ahmad et al., 2005). Use of genetic potential of plants to resist antagonistic soil condition is also an approach to recover crop productivity (Iqbal et al., 2006). Apart from it, work on different sowing/cultivation methods of wheat crop has been done so far in both normal soil (Khan et al., 2007) and saline soil (Khan, 2016) of Pakistan, to get maximum crop production.

Keeping in view the importance of bread wheat and salinity problem, a pot experiment was conducted at Amir Muhammad Khan Campus, Mardan of The University of Agriculture Peshawar, to test the performance of different wheat varieties under different salt stress condition. The purpose of research was to screen out the most suitable variety under salt affected conditions and will be grown by the farmers living in the salt affected rural areas.

Materials and Methods

An experiment in pots was conducted at Amir Muhammad Khan Campus Mardan, The University of Agriculture, Peshawar, Pakistan to screen out the most suitable bread wheat variety under different salt stress condition at seedling stage. It was designed in completely randomized design (CRD) with two factors, repeated thrice, factor 1: soils with different salinity levels and 2: wheat varieties. Five wheat varieties named Atta Habib, Barsat, Siren, PirSabak-2004 and PirSabak-2005 were obtained from Cereal Crop Research Institute (CCRI) Nowshera, (KPK)-Pakistan. These varieties were locally developed, tested as cultivar for normal soil but not in saline soil. For the experiment, three kinds of soils with respect to salt content were used. Normal soil (non-saline) was collected from a farmer's field near to Amir Muhammad Khan Campus, Mardan whereas two naturally occurring saline soils of visually different salinity collected from the farmer's fieldsat village Dubanday, Rashakai Nowshera, KPK. The collected soils were analysed for electrical conductivity (EC) and other physiochemical characteristic. On the basis of EC analysis, soils were classified as, normal soil (EC= 0.9 dS m^{-1}), moderately saline soil (EC= 7.2 dS m^{-1}) and highly saline soil (EC= 13.3 dS m^{-1}). A total number of 45 mud pots (pot size, diameter = 25 cm and height = 40 cm) were arranged in lethal house and filled with 4 kg of soil from each kind of soil. For each kind of soil, 15 pots were used (3×15= 45). Fertilizers were applied at the recommended rate i.e. 120:90:60 kg per hectare for wheat for N: P: K respectively. Calculated doses of urea (46 % N) for nitrogen, diammonium phosphate (18 % N and 46 % P_2O_5) for phosphorus, and sulphate of potash (50 % K_2O) for potassium were applied in solution form to each pot. Ten seed of each wheat variety were shown per pot randomly on 15th November, 2014. The pots were put in an open house where the temperature was 9-21 °C (night and day). The special care was given and protected from like rainy water etc. from start to end of the experiment. Pots were irrigated on saturation percentage basis

whenever required. Pots were shuffled on daily basis randomly to get uniform climatic and environmental conditions. The emergence was completed on 23 November 2014. Plants were grown for three weeks after emergence. Data on emergence percentage and plant height (cm) i.e. growth after every week of emergence were recorded.

Characterization of the soils

The soil samples were taken from the three types of soil, collected from three different fields and analysed for some physicochemical properties on standard methods and procedures (Table 1). The laboratory analysis showed that the soil-1, soil-2 and soil-3 were normal, moderate and high salt affected with EC value of 0.9, 7.2 and 13.3 dS m^{-1} respectively. As regard soil pH, ranged from 7.8 to 8.79. All the soils were moderately calcareous (3-13%). As per analysis in laboratory, all the soils were also low in AB-DTPA Ext. P and K. The texture of the three soils was silt loam. All the soils were low in organic matter content (Table 1).

Table 1: *Physico-Chemical properties of soils before sowing.*

Soil Physico-Chemical Properties	Normal Soil (Soil 1)	Moderate salt Affected Soil (Soil 2)	Highly Salt Affected Soil (Soil 3)
EC $_{(1:2)}$ dS m^{-1}	0.9	7.2	13.3
pH $_{(1:2)}$	7.8	8.42	8.90
*AB-DTPA Ext. P (mg kg^{-1})	2. 38	1.21	0.86
AB-DTPA Ext. K (mg kg^{-1})	117	85	71
% $CaCO_3$	11.40	9.84	8.39
% Clay	17.4	13.14	19.4
% Silt	56	70	68
% Sand	26.6	16.86	12.6
Texture Class	Silt loam	Silt loam	Silt loam
% Organic matter	0.54	0.35	0.22

**Ammonium Bicarbonate-Diethylene Triamine Pentaacetic Acid Extractable (AB-DTPA Ext.).*

Statistical analysis

The data collected on wheat's emergence and plant heights were statistically analysed using Statistix 8.1 software according to the procedure given by Steel and Torrie (1980) relevant to analysis of variance of complete lyrandomized design with two factors. Least significance difference (LSD) test was used to separate the means (Steel and Torrie, 1980).

Results and Discussion

Percent emergence

Statistical analysis of the data showed that emergence percentage was significantly ($p < 0.05$) affected by different soils while non-significant by varieties (Table 2). Data regarding soils showed that the significantly highest emergence (87 %) of varieties was observed in normal soil followed by moderately and highly salt affected soils i.e 20 % and 17 %. Differences between the emergence percentage of highly salt affected soil and moderately salt affected soil was statistically at par. The interactions of per cent emergence between soil and varieties were found significant ($p< 0.05$) (Table 2). Data regarding interactions, in normal soil the highest rate of emergence (100%) was observed by Pirsabak 2004 variety followed by siren (97 %). In moderately saline soil, the highest percent emergence (27 %) was recorded by Siren. In high salt affected soil the highest emergence rate (30%) was observed by Atta Habib variety and lowest by Pirsabak 2004 and Pirsabak 2005 (Table 2).

Table 2: *Percent emergence of wheat varieties in different soils.*

Soils	Varieties					Mean
	V1	V2	V3	V4	V5	
S1	67	77	97	100	93	87 A
S2	20	23	27	13	17	20 B
S3	30	17	13	13	13	17 B
Mean	39	39	45	42	41	

LSD (5%)for soils: *12.59; Means followed by different letter(s) are significantly different from each other;* **S1:** *Normal Soil,* **S2:** *Moderately Salt Affected Soil,* **S3:** *highly Salt Affected Soil;* **V1:** *Atta Habib,* **V2:** *Barsat,* **V3:** *Siren,* **V4:** *Pirsabak-2004,* **V5:** *Pirsabak-2005.*

Salinity may retards germination due to less nutrient availability that decreased the osmotic potential to such a point that water necessary for mobilization of nutrient become unavailable. These results are in accordance with the work of Ismail (2003); Ahmad et al. (2005) and Mirzaei et al. (2012).

Growth (Plant height)

Data on plant height (cm) was taken at three week intervals.

1st Week: Plant height (cm)'s data after first week of emergence is shown in Table 3. Statistical analysis

showed that growth was significantly (p< 0.05) affected by both soils and varieties. Mean values showed that growth rate in normal soil was significantly high as compared to highly salt affected soil and moderately salt affected soil. The growth rate of moderately salt affected soil and highly salt affected soil were statistically at par (Table 3).

Table 3: *Growth in plant height (cm) of wheat varieties in differentsoils after 1st week of emergence.*

Soils	Varieties					Mean
	V1	V2	V3	V4	V5	
S1	1.67	3.97	3.77	0.87	3.30	2.71 A
S2	0.97	0.63	1.17	0.50	0.63	1.42 B
S3	1.03	0.53	0.53	0.43	0.53	0.61 B
Mean	1.22 B	1.71 A	1.82 A	0.6 B	1.48 AB	

LSD (5%): *0.5783; Means followed by different letter(s) are significantly different from one another;* **S1:** *Normal Soil,* **S2:** *Moderately Salt Affected Soil,* **S3:** *Highly Salt Affected Soil;* **V1:** *Atta Habib,* **V2:** *Barsat,* **V3:** *Siren,* **V4:** *Pirsabak-2004,* **V5:** *Pirsabak-2005.*

The interactions of plant height among soils and varieties were significant (p<0.05) (Table 3). Results revealed that the highest plant height (3.97 cm) was observed by Barsat variety in normal soil while the lowest plant height (0.87 cm) in Pirsabak-2004 variety. In highly salt affected soil the highest plant height (1.03 cm) was observed in Atta Habib variety and the lowest plant height (0.43 cm) in Pirsabak-2004 variety. In moderately salt affected soil, the highest plant height (1.17 cm) was recorded in Siren variety while the lowest plant height (0.5 cm) was observed in Pirsabak-2004 variety. Root zone salinity enhancement caused reduction in plant growth and poor production of wheat grains (Steppun and Wall, 1997; Ahmad et al., 2005; Ali et al., 2007; Qayyum et al., 2007; Khan et al., 2008; Asadi et al., 2012). Salinity also played role in reducing number of leaves in main stem, number of spikelet per spike and number of kernels per spike in wheat (Maas and Grieve, 1990).

2nd Week: Data on plant height (cm) after 2nd week of emergence were collected. Statistical analysis of the data showed that the effect of both soil and variety were significant (P<0.05) (Table 4). The significantly highest plant height (4.51 cm) was obtained in the normal as compared to the other two soils of which the plant height was statistically at par. The interaction data of growth between soils and varieties were significant (p<0.05) (Table 4). Among interactions, the data revealed that in normal soil the highest plant height (6.43 cm) was observed from Barsat variety while the lowest plant height (3.0 cm) from Pirsabak-2004. In highly salt affected soil, the highest plant height (1.80 cm) was noted from Atta Habib variety while the lowest plant height (1.17 cm) from Pirsabak-2004. In moderately salt affected soil, the highest similar plant height (1.43 cm) was recorded from Siren, Barsat and Pirsabak-2004 variety and the lowest plant height (1.20 cm) from Pirsabak-2005.Increase in root zone salinity causes decline in plant height and quality of wheat grains (Steppun and Wall, 1997; Ahmad et al., 2005; Ali et al., 2007; Qayyum et al., 2007; Khan et al., 2008; Asadi et al., 2012). Salinity played role in reducing number of leaves in main stem, number of spikelet per spike and number of kernels per spike in wheat (Maas and Grieve, 1990).

Table 4: *Growth in plant height (cm) of wheat varieties in different soils after 2nd week of emergence.*

Soils	Varieties					Mean
	V1	V2	V3	V4	V5	
S1	3.13	6.43	5.43	3.00	4.53	4.51 A
S2	1.03	1.43	1.43	1.43	1.20	1.42 B
S3	1.80	1.37	1.40	1.17	1.37	1.51 B
Mean	2.32 B	3.07 A	2.76 A	1.87 B	2.37 AB	

LSD (5%): *1.34; Means followed by different letter(s) are significantly different from each other;* **S1:** *Normal Soil,* **S2:** *Moderately Salt Affected Soil,* **S3***: highly Salt Affected Soil;* **V1:** *Atta Habib,* **V2:** *Barsat,* **V3:** *Siren,* **V4***: Pirsabak-2004,* **V5:** *Pirsabak-2005.*

3rd Week: Data on plant height (cm) after 3rd week of emergence showed that different salinity levels and varieties significantly (p<0.05) affected plant height (Table 5). The significantly highest plant height (6.2 cm) was obtained in normal soil followed by the plant height in highly salt affected soil. The interactions of plant height between soils and varieties were also significant (p<0.05) (Table 5). Results showed that the highest plant height (9.93 cm) in highly salt affected soil was observed from Atta Habib variety while the lowest plant height (4.4 cm) from Pirsabak-2004. In highly salt affected soil, the highest plant height (3.77 cm) was obtained from Atta Habib variety while the lowest plant height (2.56 cm) from Siren. In case of moderately salt affected soil, the highest plant height (3.3 cm) was also recorded from Atta Habib variety and lowest plant height (2.26 cm) from Pirsabak-2004 variety (Table 5).

Table 5: *Growth in plant height (cm) of wheat varieties in different soils after 3rd week of emergence.*

Soils	Varieties					Mean
	V1	V2	V3	V4	V5	
S1	9.93	5.06	5.96	4.4	5.66	6.2 A
S2	3.30	2.96	3.03	3.0	2.26	2.9 C
S3	3.77	3.10	2.56	3.13	3.23	3.7 B
Mean	5.66A	371B	3.85 B	3.51 B	3.71 B	

LSD (5%): *0.874; Means followed by different letters are significantly different from each other;* **S1:** *Normal Soil,* **S2:** *High Salt Affected Soil* **S3***: Moderate Salt Affected Soil;* **V1:** *Atta Habib,* **V2:** *Barsat,* **V3:** *Siren,* **V4:** *Pirsabak-2004,* **V5:** *Pirsabak-2005.*

Reduction in plant height in high salinity level might be due to specific ion effect. As the concentration of specific ions like chlorides and sulphates increased, it caused a decline in normal plant growth. These results were in accordance with Ahmad et al. (2005), Ali et al. (2007), Qayyum et al. (2007), Khan et al. (2008) and Asadi et al. (2012). Increase in root zone salinity causes decline in plant height and quality of wheat grains (Steppun and Wall, 1997). Salinity played a major role in reducing number of leaves in main stem, number of spikelets per spike and number of kernels per spike in wheat (Maas and Grieve, 1990).

Conclusions and Recommendations

From the overall results, it was concluded that Atta Habib variety has the highest emergence percentage and plant height in salt affected soil at seedling stage along with its good performance in normal and moderate salt affected soils as well.

Thus, the cultivation of Atta Habib variety in salt stressed conditions is recommended for wheat production. It is further recommended that cultivation of Atta Habib variety in normal soil can also increase yield and production of wheat.

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Author's Contribution

Shamsher Ali, conceived the idea, planned the experiment, write up and overall management of the research article. Mr. Sarmad Khan, conducted the experiment and data collection. Muhammad Jamal Khan, helped in writing of material and methods. Naveed ullah helped in data analysis. Muhammad Rashid helped in soil analysis in Laboratory. Wiqar Ahmad, helped in data entry and proof reading.

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