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Effect of Different Salinity Levels on the Yield and Yield Components of Wheat Cultivars

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Abstract: Statistical analysis of the data revealed that yield and yield components of Wheat cultivars were significantly ($p < 0.05$) affected by different salinity levels. Agronomic characters i.e. plant height, tillers plant^{-1}, number of grains plant^{-1}, 100 grains weight, grain and straw yield and harvest index of two salt tolerant cultivars (Mutant and Lu 26S) were reduced less than salt sensitive cultivars (Yecora and WS 711). Mutant and Lu 268 proved more salt tolerant than other cultivars at all growth stages. It could be concluded from these findings that grain yield was more adversely affected by salinity than straw production.

Key words: Salinity, yield, wheat, salinity level

Introduction

The economy of Pakistan is pre-dominantly agrarian and prosperity of people depend upon the proper management of cultivated land. Large area in the country are in the severe grip of salinity and water logging. Salinity hold a very crucial position amongst a multitude of problems, while agricultural land in Pakistan is facing to day. Out of 14 million hectare of irrigated land, 5.82 million hectare have been adversely affected by salinity/sodicity 2.5 million is saline, 3.2 million is saline sodic and 0.12 million is non saline sodic (Mohammad, 1983). Many Research workers are engaged in the selection, adaptation or breeding of salt tolerant cultivars (Kingsbury and Epstein, 1904; Francois *et al*., 1986; Rashid, 1986; Bernal *et al*., 1974). Salinity effects are complex and probably involves the expression of a number of genes and the importance of the expression of each may depend upon its interaction with other genes, external salt concentration, stage of growth and other environmental conditions.

Materials and Methods

A pot experiment was conducted in the green house of NWFP. Agricultural University Peshawar, Pakistan during 1990. The experiment was laid out in two factor factorial completely randomized design. The study was conducted in plastic tubes of 30 cm diameter and 30 cm deep, which were filled with soil mixture (soil + sand + humus; 3:1:1). Four cultivars, Lu 265, Mutant, yecora and WL 711 were used in the experiment. Soil were brought to field capacity. In each tube the above four cultivars were sown and subsequently thinned to five seedlings of each cultivar. After 15th day of seedling growth, the tubes were artificially salinized to 1.2 (control), 10 and 20 dS m^{-1} of salinization extract with NaCl + $CaCl_2$ in the ratio of 9:1 in increment of 6 dS m^{-1} with each irrigation. Plants were allowed to grow upto maturity. At the tillering stage nitrogen was applied at the rate of 27.6 kg ha^{-1} in the form of Urea. Plants were irrigated according to their need for water. Observations were recorded on plant height, number of tillers plant^{-1}, number of grains plant^{-1}, grain weight plant^{-1}, 100 grain weight, total straw plant^{-1} and harvest Index.

Results and Discussion

Table 1 shows that plant height was significantly affected by salinity levels, cultivars and their interaction. Plant height was reduced due to the application of salt and cumulative reduction of 25 and 35% were noted at 10 and 20 dS m^{-1} respectively when compared with control Lu 268 had significantly taller plants than other cultivars at all salinity levels i.e. 68.7 and 55.7 cm respectively. Plant height decreased in all other cultivars with the addition of salt. Maximum reduction were found in WL 711 at both salinity levels. Accumulation of excessive salts in the cell wall modify the metabolic activities of the cell and limits the cell wall elasticity. In addition, secondary cell appears sooner and cell wall become rigid as a consequence the tugor pressure efficiency in cell enlargement decrease. These processes may cause the plant to remain dwarf (Everardo *et al*., 1975; Aslam *et al*., 1993). Similar adverse effect of salinity on plant height was also reported by Kingsbury and Epstein (1904). Zehid *et al*. (1986), Singh and Rana (1987) and Sharma and Swarm (1987).

Table 2 presents data concerning number of tillers plant^{-1}. Analysis of the data indicated that salinity levels, cultivars and their interactions had a significant effect on number of tillers plant^{-1}. It can be inferred from the data shown in Table 2 number of tiller plant^{-1} was reduced by 31 and 54% due to the addition of 10 and 20 dS m^{-1} salt respectively over control. Mutant has significantly more number of tiller plant^{-1} at control and different salinity levels. Tillers plant^{-1} at control and at different salinity levels. Tiller plant^{-1} decreased in all other cultivars with the addition of salts, maximum reduction being observed in WL 711 at 10 and 20 dS m^{-1} salinity levels. Reduction in the number of tillers. plant^{-1} under saline condition may be due to energy metabolic limitatations (Greenway and Munns, 1983), decreased permeability or enzymes activities (Narale *et al*., 1969). Similar results were also reported by Belolyubstkaya (1981).

Data regarding grains plant^{-1} is shown in Table 3. Statistical analysis of the data revealed that grains plant^{-1} were significantly affected by salinity levels, cultivars and their interaction. Data presented in Table 3 indicated that salinity had and adverse effect on number of grains plant^{-1}. Maximum reduction were noted at 10 and 20 dS m^{-1} salinity levels respectively when compared with control. Lu 26S had significantly more number of grains plant^{-1} than other cultivars at all salinity levels. Contrary to these results Singh and Rana (1987) found that WL 711 performed better than the other Wheat cultivars when exposed to different salinity levels.

Table 1: Effect of salinity on plant height at maturity of four wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
	------------- cm/plant -------------			
LU-26S	73.6a	68.7a (93)	55.7a (76)	66.0a
Yecora	56.7b	39.5b (69)	34.8b (61)	43.7b
Mutant	69.0c	53.2b (77)	48.5c (70)	56.9c
WL-711	69.0d	42.0c (60)	36.0d (52)	49.0d
Mean	67.1a	60.8b (75)	43.8c (65)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 5% level of probability in each column.

Table 2: Effect of salinity on number of tillers plant^{-1} of four wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
	-------- tillers/plant -------			
LU-26S	6.0ab	4.0b	3.0s	4.3ab
Yecora	5.0b	3.7b	2.0b	3.6b
Mutant	7.0a	5.3a	3.1a	5.1a
WL-711	5.4b	3.3b	2.0b	3.6b
Mean	5.9a	4.1b(69)	2.6c (44)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 5% level of probability in each column.

Table 3: Effect of salinity on number of grains plant^{-1} of four Wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
	--------grain/plant-------			
LU-266	231a	192a (83)	168a (72)	197a
Yecora	174c	102c (58)	81c (46)	119c
Mutant	178bc	160b (84)	135b (75)	163b
WL-711	183b	105c (57)	72d (39)	120c
Mean	139.5e	140.8b (72)	114.0c (58)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 5% level of probability in each column.

Table 4: Effect of salinity on 100 train weight of four wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
	----------gms---------------			
LU-26S	3.45a	3.30a (93)	2.85a (82)	3.23a
Yecora	3.43a	3.15b (62)	2.03b (59)	2.54b
Mutant	3.50a	3.37a (94)	2.88a (82)	3.25a
WL-711	3.45a	2.51b (72)	2.06b (59)	2.67b
Mean	3.46a	2.85b (82)	2.46c (71)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 5% level of probability in each column.

Table 5: Effect of salinity on grain yield plant^{-1} of four Wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
	--------- gm/plant ---------			
LU-26S	8.2a	5.5a (67)	3.8 a(46)	5.8a
Yecora	6.0c	2.2c (37)	1.7c (27)	3.3c
Mutant	6.5b	4.2b (65)	2.9b (45)	4.5b
WL-711	6.4b	2.2c (34)	1.5c (23)	3.4c
Mean	6.8a	3.5b (51)	2.5c (36)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 5% level of probability in each column.

Table 6: Effect of salinity on dry weight of straw plant^{-1} of four Wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
	---------- gm/plant -----------			
LU-26S	27.43b	22.14b (80)	20.44a (74)	23.34b
Yecora	25.36c	13.47d (53)	12.48c (49)	17.10d
Mutant	28.54a	23.78a (83)	19.57b (69)	23.97a
WL-711	28.51a	14.79c 152)	12.28c (42)	18.51c
Mean	27.48a	18.55b (67)	16.18c (58)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 5% level of probability in each column.

Table 7: Effect of salinity on harvest index of four Wheat cultivars

Cultivars	(Average of three replicates) Salinity levels dS m^{-1}			
	1.2 (control)	10	20	Mean
LU-26S	23.0a	19.7a (85)	16.3a (71)	19.67a
Yecora	19.1b	14.3c (74)	11.8c (62)	15.10b
Mutant	18.5bc	15,0b (81)	12.8b (70)	15.43b
WL-711	18.2c	13.0d (71)	10.7d (59)	13.97c
Mean	19.7a	15.5b (78)	12.9c (65)	

Figures in parenthesis indicate plant height as percentage of the respective control. Mean value followed by the same letters are statistically non significant among themselves at 6% level of probability in each column.

It can be seen from the data presented in Table 4 that grains weight was progressively reduced due to the application of salt. Maximum reduction of 82 and 71% was noted at 10 and 20 dS m^{-1} respectively. Mutant and Lu 265 had more 100 grains weight than Yecora and WL 711 at medium and higher salinity levels. However, at control the grain weight of all cultivar were statistically non significant among themselves. Maximum reduction were noted in Yecora at 10 and 20 dS m^{-1} respectively.

Table 5 presents data regarding grain yield plant^{-1}. Statistical analysis of the data revealed that grain yield was significantly affected by salinity levels, cultivars, and their interaction. Data shown in Table 5 shows that addition of salt progressively reduced grain yield plant^{-1}. Maximum reduction in grain yield plant^{-1} was noted at 10 and 20 dS m^{-1} respectively when compared with control. The poor yield under saline environment may be attributed to salt induced shrinkage and even complete damage of chloroplast (Stroganov, 1962). There may be also indirect effect fo salt on plant growth due to decrease in photosynthates in the phloem. Water deficiency in the growing regions may occurs because of insufficient osmotic adjustment or increase resistance to water flow (Munns *et al*., 1982; Greenway and Munns, 1983; Flowers *et al*., 1991). In addition, selective absorption of essential ions under saline environment for osmotic adjustments is an energy demanding process and plant uses its energy at the cost of growth and economic yield (Nieman, 1980; Yeo, 1983). Lu 26S had significantly more grain yield plant^{-1} than the other cultivars at control and other salinity levels followed by Mutant. Addition of salt decreased grain yield plant^{-1} in all cultivars, minimum yield was recorded in WL 711 at 10 and 20 dS m^{-1} salinity levels. Similar results were also reported by Verma and Neue (1984), Zehid *et al*. (1986) and Francois *et al*. (1986).

Straw yield plant^{-1} data is indicated in Table 6. Analysis if the data revealed that salinity levels, cultivars, and their interactions had a significant effect on straw yield plant^{-1}. Data shown in Table 6 confirm that straw yield plant^{-1} was significantly reduced due to the addition of salt in the soil. Straw yield plant^{-1} was significantly reduced due to the addition of salt in the soil. Straw yield plant^{-1} was reduced 33% at 10 dS m^{-1} and 42% at 20 dS m^{-1} salinity levels when compared with control. Mutant had significantly more straw yield at control and 10 dS m^{-1} salinity levels, while at 20 dS m^{-1}, Lu 26s produced more straw yield than other cultivars. Yecora and Wl 711 produced significantly lower straw yield plant^{-1} than Lu 265. Verma and Neue (1984) also reported similar results. Results presented in Table 7 revealed that harvest index was reduced due to the application of salt. Pots salinized with 10 and 20 (15 m^{-1} salinity levels reduced harvest index by 22 and 35% respectively when compared with control. Lu 26S presented significantly more harvest index than other cultivars at all salinity levels followed by Mutant, Yecora and WL 711. On the basis of growth and yield performance wheat cultivars LU-26S and Mutant could be scored as salt tolerant while Yecora and WL-711 as salt sensitive ones.

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