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# SCREENING OF WHEAT (*TRITICUM AESTIVUM* L.) CULTIVARS FOR SALINE CONDITIONS UNDER IRRIGATED ARID ENVIRONMENT

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**Abstract:** Eight wheat cultivars were evaluated for yield and yield components under saline conditions of irrigated arid environment of Multan. The cultivars comprised: Manthar-3, Panjnad-1, BWP-2000, Inqlab-91, Iqbal-2000, SARC-1, BWP-97 and Darawar-97**.** The cultivar Punjnad-1 produced more tillers than all the other genotypes. But this cultivar could not maintain its position. In production of spikes, filled spikelets, 1000-grain weight, grain yield and harvest index, the cultivar Punjnad-1 was among the cultivars showing poor performance. This indicted that the existence of excessive tillers was drain to wheat plant reserves. On the basis of grain yield the cultivars SARC-1 and Iqbal-2000 were found relatively salt tolerant. The cultivars Manthar-3, Darawar-97, Panjnad-1, BWP-2000, BWP-97 and Inqlab-91 were found relatively less tolerant to salinity. The cultivars Iqbal-2000, SARC-1, Panjnad-1 and BWP-97 performed better in biological yield. The cultivars BWP-2000 and SARC-1 showed statistically higher values of harvest index among the wheat cultivars tested under saline conditions. The wheat cultivars having excessive tillering capacity should be avoided to grow in salt affected areas. Future breeding efforts in the salt affected areas should focus on wheat cultivars having balanced vegetative growth.

**Keywords:** Irrigated arid environment, saline conditions, wheat cultivars.

## INTRODUCTION

Considerable salts are dissolved in water either derived from rivers or drawn from underground aquifers for irrigation and accumulate in surface soils through distillation by evapotranspiration [Loomis and Connor 1992]. The accumulated salts in the profiles of soils affect crop plants in three major ways: osmotic stress through decreasing water availability (hence nutrient availability), ionic stress, and changes in the cellular ionic balance [Kirst 1989].

The wheat crop is a moderately salt tolerant and reasonably good yield can be obtained by some management practices and/or selection of relatively more salt tolerant cultivars. The threshold electrical conductivity and the salt sensitivity (% yield reduction per dS $m^{-1}$) for wheat have been found 6.0 dS $m^{-1}$ and 7%, respectively [Maas 1984]. Final yield of a crop depends upon the performance of yield components. Salinity decreases the number of spikelets in the main spike of wheat [Frank *et al*. 1987]. Soil salinity affects the normal development and viability of tillers; it also decreases the number of primary and secondary tillers [Ayers *et al*. 1967]. The yield component most affected under salinity stress is the reduction of the number of culms that bear ears [Maas *et al*. 1994]. The toxicity to the plant caused by salinity stress is particularly evident after anthesis. It is characterized by early senescence and low kernel weight

[Jones and Gorham 1991], as well as the abortion of distal spikelets [Grieve *et al*. 1992]. Wheat yield is decreased by 50 percent at soil saturation extracts of 13 dS $m^{-1}$ [Ayers and Westcot 1976]. High concentration of salts in the root zone decreases grain yield and yield component of wheat. Except number of spikelets, all yield components of wheat (number of tillers, total biomass, number of spikes, 100 grain weight and grain yield) were significantly affected under saline hypoxic conditions [Saqib and Qureshi 1998]. Grain and straw yield reduction was up to 69 and 64 percent, respectively, under severe salt stress [Khan *et al*. 1999]. An increase in salinity level lead to an increase in days to tillering in wheat cultivars but the effect on booting and days to inflorescence was not as pronounced [Baalbaki 2001].

Management, reclamation and selection of salt tolerant cultivars within crop species can increase the share of the area of salt affected soils to the total productivity of crops. The selection of relatively salt tolerant cultivars within crop species is the rapid and economical method to increase the productivity of crops in salt-affected areas. The present study was aimed at the evaluation of wheat cultivars for salt tolerance under saline conditions of arid environment.

## MATERIALS AND METHODS

The eight wheat cultivars were evaluated for salt tolerance at the Research Farm of University College of Agriculture, Bahauddin Zakariya University, Multan. The soil of the site had pH 8.3 (medium alkaline), EC 7.5 dS $m^{-1}$ (slightly high), exchangeable sodium percentage 16% (slightly high), organic matter 0.45% (very low) nitrogen 0.028% (very low), average phosphorus 9 ppm (low) and exchangeable potassium 110.0ppm (medium). The wheat cultivars comprised of Manthar-3, Panjnad-1, BWP-2000, Inqlab-91, Iqbal-2000, SARC-1, BWP-97 and Darawar-97**.** The parameters studied were number of tillers ($m^{-2}$), number of spikelets/ spike, number of filled spikelets/spike, biological yield ($ha^{-1}$), economic yield ($ha^{-1}$), 1000-grain weight (g), and harvest index.

The number of tillers was counted in an area enclosed by a quadrate (1.0 $m^2$) thrown twice randomly in each plot and then averaged. Ten plants were selected randomly to record data on spikelets and filled spikelets and averages thereof were calculated to convert into per spike. To record data on biological yield, economic yield and 1000-grain weight the crop was harvested manually and was stacked for seven days before manual threshing. The threshed grains were sun dried and weighed to record economic yield. Wheat straw was also dried to include in biological yield. Biological yield comprised economic and straw yields. To record 1000-grain weight, three samples of 1000 grains were counted from the seed lot of each plot and weighed on an electric balance. The average weight of the three samples was taken as 1000-grain weight. The harvest index was obtained by calculating the ratio between economic yield and biological yield then multiplied by 100.

## RESULTS AND DISCUSSION

### NUMBER OF TILLERS

The number of tillers ($m^{-2}$) ranged between 278.3 and 462.7 (Table 1). The wheat plant produces a number of secondary culms called tillers. Under favorable conditions, a wheat plant may produce one hundred or more tillers [Arnon 1972]. Unfavorable conditions influence the capacity of plants to produce tillers. The cultivar BWP-97 produced the lowest number of tillers (278.3) per square meter while the cultivar Panjnad-1 produced the highest number of tillers (462.7) per square meter. In salinity sensitive cultivars, the salts suppressed the tillering capacity. The suppression of tillering capacity of the wheat cultivars by salinity has been reported earlier [Singh 1995, Saqib and Qureshi 1998]. The differential behavior of wheat cultivars to produce tillers under saline conditions indicated the morphological plasticity. It is suggested that the seed rate of cultivars producing less tillers should be increased to compensate the loss of tillers under saline conditions.

**Table 1:** Number of tillers, number of spikelets, filled spikelets, biological yield, economic yield, 1000-grain weight and harvest index of wheat cultivars under saline conditions

| Cultivars | Tillers ($m^{-1}$) | Spikelets per spike | Filled spikelets | 1000-grain weight (g) | Biological yield (tons $ha^{-1}$) | Grain yield (tons $ha^{-1}$) | Harvest index |
|---|---|---|---|---|---|---|---|
| Manthar-3 | 301.7 d | 21.33 ab | 18.0 b | 31.92b | 11.45 bc | 3.93 b | 26.61 bcd |
| Panjnad-1 | 462.7 a | 19.00 c | 15.0 c | 26.98d | 12.54 ab | 3.30 b | 26.95 bcd |
| BWP-2000 | 324.3 c | 19.67 bc | 17.0 b | 31.06c | 10.40 c | 3.35 ab | 32.50 a |
| Inqlab-91 | 327.0 c | 19.33 bc | 16.33 bc | 29.27ef | 11.19 bc | 3.07 b | 27.90 abc |
| Iqbal-2000 | 335.3 c | 20.67 bc | 17.0 b | 28.94f | 13.31 a | 3.05 b | 22.96 d |
| SARC-1 | 442.3 b | 23.0 a | 20.67 a | 33.64a | 12.17 ab | 3.74 a | 30.55 ab |
| BWP-97 | 278.3 e | 20.0 bc | 17.0 b | 31.48bc | 13.39 a | 3.30 b | 24.65 cd |
| Darawar-97 | 281.0 e | 20.0 bc | 17.0 b | 29.72de | 10.45 c | 2.97 b | 28.76 abc |

Means not sharing a common letter in a column differ significantly at 0.05% level of probability

### NUMBER OF SPIKELETS

The number of spikelets per spike ranged between 19.0 and 23.0 (Table 1). It is evident from the results that the cultivar SARC-1 produced maximum number of spikelets per spike (23.0). The cultivar Panjnad-1 produced statistically lower number of spikelets per spike (19.0) than that of others. The cultivars Drawar-97, BWP-97, Iqbl-2000, and BWP-2000 were statistically at par with Panjnad-1. The decreased number of spikelets per spike in wheat cultivars may be attributed to accelerated apex development and reduced number of leaves at the main stem. At the stage of ear emergence, salinity affects the reproductive development, spikelet initiation and hence final number of spiklets [Mans and Rawson 2004]. The reduced number of tillers has been known to be associated with salinity [Salam *et al*. 1999].

## NUMBER OF FILLED SPIKELETS

The number of filled spikelets ranged between 15.0 and 20.6 (Table 1). The cultivar Panjnad-1 had the lowest number of filled spikelets (15.0) followed by Inqlab-91 (16.33). The cultivar SARC-1 was superior in having filled spikelete per spike (20.6) than the all others. The cultivar SARC-1 showed better performance at grain filling stage than vegetative stage in saline conditions. A significant variation among wheat cultivars to produce filled spikelets has been found under saline conditions [Ahsan and Wright 1998]. The partitioning of net accumulated assimilates play an important role during the later stages of growth. Probably better partitioning and current supply of photosynthates contributed to greater number of filled spikelets per spike.

## ECONOMIC YIELD

Economic yield ranged between 3.74 to 2.97 tons $ha^{-1}$ (Table 1). The cultivar SARC-1 produced maximum (3.74 tons $ha^{-1}$) and the cultivar Darawa-97 produced minimum (3.74 tons $ha^{-1}$) economic yield. The cultivar BWP-2000 was at par with SARC-1. The yields of cultivars BWP-97, Iqbal-2000, Inqlab-91, Panjnad-1 and the Manthar-3 were also affected by salinity with same degree as Drawar-97. The salinity decreased the number of filled spikelets per panicle hence increased number of sterile spikelets and also salinity reduced the individual grain size of rice [Zeng and Shannon 2000]. The negative effect of salts on number of spikelets and seed weight was the reason of low yield in salt sensitive cultivars. From agronomic point of view, final seed/grain yield is the main goal. Earlier many workers have classified crop genotypes on the basis of final seed/grain yield under stress conditions [Sadiq *et al*. 1994, Anderson *et al*. 1996, Watanabe and Terao 1998]. On the basis of grain yield the cultivars SARC-1 and Iqbal-2000 were found relatively salt tolerant. The cultivars Manthar-3, Darawar-97, Panjnad-1, BWP-2000, BWP-97 and Inqlab-91 were found relatively less tolerant to salinity. The variation in grain yield of wheat cultivars can be explained in terms of pattern of leaf growth and dry matter accumulation, duration of leaf area and grain size. The leaf growth at lateral stages plays very important role in yield, as the lower leaves are generally inactive during the later phases of grain maturation; reserves in the stem itself are also at low level, and for this reason their contribution to kernel development is of little importance [Bunting and Drennan 1966]. The stage of dry matter accumulation and partitioning of photosynthates contribute substantially to grain yield. Assimilation after anthesis, size, duration, and photosynthetic activity plant parts still green after the ear emerge namely those parts above flag-leaf node, including the ear determine the yield potential of wheat plants [Bunting and Drennan 1966]. The cultivars Manthar-3 and Inqlab-91 showed comparatively high vegetative growth at the early stages but lower economic yield; on the other hand cultivars

SARC-1 and Iqbal-2000 had more grain yield but less vegetative growth at the early stages. The reason of low yield in the cultivars having more relative growth rate at the early growth stages might be due to the senescence and wilting of leaves during the reproductive stage. The low yield can also be attributed to the stage of dry matter accumulation. In another our study (unpublished), it was obvious from the results that high yielding cultivars showed better net assimilation rate at 57 days after sowing. This was the period just prior to anthesis. The salinity tolerant cultivars SARC-1 and Iqbal-2000 maintained their leaf growth at lateral stages and hence produced high economic yield. Singh *et al*. [1988] and Nair and Khuble [1990] classified the wheat cultivars on the basis of grain yield under saline conditions.

## BIOLOGICAL YIELD

The biological yield ranged between 10.40 to 13.39 tons $ha^{-1}$ (Table 1). The biological yield was the highest (13.39 tons $ha^{-1}$) in cultivar BWP-97 followed by cultivars Panjnad-1, SARC-1 and Iqbal-2000, which were statistically at par with one another. The biological yield was the lowest (10.40 tons $ha^{-1}$) in cultivar BWP-2000. In biological yield, the performance of Inqlab-91, Drawar-97 and Manthar-3 was similar to that of BWP-2000. Biological yield is the sums total of grain yield and straw yield. Up to 64 percent reduction in straw yield of wheat by salinity has been reported [Khan *et al*. 1999].

## 1000-GRAIN WEIGHT

The 1000- grain weight ranged between 33.64 to 28.94 g (Table 1). It is evident from the results that maximum 1000- grain weight (33.64 g) was obtained in cultivar SARC-1 and minimum (28.94 g) in cultivar Iqbal-2000 followed by Inqlab-91. The cultivars, which showed more number of tillers, spikelets, filled spikelets, economic yield and biological yield also showed higher 1000-grain weight. In salt sensitive cultivars, no compensation of one yield parameter by other was observed. Moreover in salinity sensitive cultivars, osmotic potential might be increased in the root zone and the availability of water to above plant parts restricted due to presence of salts. Water was essential for seeds to increase their size at that time. Due to lack of water, grains shriveled. The shriveled grains have low weight. Earlier wheat cultivars showed the existence of high linear interaction for 1000-grain weight with salinity and alkalinity [Singh 1995].

## HARVEST INDEX

The harvest index of the wheat cultivars ranged between 22.96 and 32.50 (Table 1). Harvest index was highest (32.50) in cultivar BWP-2000 and was the lowest (22.96) in cultivar Iqbal-2000. The cultivars Drawar-97 and SARC-1 were at par to cultivar BWP-2000. The harvest indices of the cultivars BWP-97, Manthar-3 and Panjnad-1 were affected by salinity with the same magnitude as Iqbal-2000. The presence of salts in the vicinity of plant roots has significant effect on harvest index [Zeng and Shannon 2000]. The cultivar Iqbal-2000 showed higher biological yield but lower economic yield and hence lower harvest index. The cultivar BWP-2000 had high economic yield and less biological yield and showed the highest value of harvest index.

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