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Full Length Research Paper

Effect of seed priming on growth and biochemical traits of wheat under saline conditions

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Effects of seed priming with 30 mM NaCl was determined on various growth and biochemical characters of 6 wheat varieties (Tatara-96, Ghaznavi-98, Fakhri Sarhad, Bakhtawar-92, Pirsabaq-2004 and Auqab-2000) under 4 salinity levels (0, 40, 80 and 120 mM). Statistical analysis of the data revealed that varieties, salinity and seed priming had significantly ($P \leq 0.05$) affected germination (%), days to emergence, tillers plant^{-1}, leaves plant^{-1} and shoot chlorophyll-b contents (mg g^{-1} fresh weight). However, the effects of varieties and salinity were significant ($P \leq 0.05$) and of seed priming was non significant ($P > 0.05$) on plant height (cm), root length (cm) and shoot chlorophyll-a contents. Maximum germination percentage (88.75), tillers plant^{-1} (3.63), leaves plant^{-1} (16.01), plant height (27.86 cm), root length (18.57 cm), shoot chlorophyll-a contents (1.15 mg g^{-1} fresh weight) and shoot chlorophyll-b contents (0.84 mg g^{-1} fresh weight) were recorded for Bakhtawar-92. Maximum days to emergence (10.04) were recorded for Pirsabaq-2004.

Key words: Seed priming, growth, wheat varieties, salinity.

INTRODUCTION

Agricultural crops are facing various types of biotic and abiotic stresses. Among the abiotic stresses, soil salinity adversely influences the crop production (Hameed et al., 2008; Bakht et al., 2006, 2007, 2011; Shafi et al., 2009, 2010, 2011). Salts may influence plant growth by causing direct injury to the growing cells or indirectly by reducing the amount of water reaching the growing region and photosynthates (Mass and Nieman, 1978). Salt stress induces water stress by decreasing the osmotic potential of the soil solutes and thus making it very difficult for roots to extract the required water from its surrounding media. The effects of higher salt stress on plants can be observed in terms of decreased productivity or plant death (Parida and Das, 2004). Plant response to salt stress is very complex and depends upon the duration of salinity, developmental stage of plant at salt exposure, type of salt and many other factors (Cramer et al., 2001). At higher salinity levels, the crop yield is decreased so drastically that cultivation of crop becomes uneconomical without amendments of soil. Crop growth resumes when the salt stress is relieved. Wheat (*Triticum aestivum* L.), the major staple food in Pakistan, is grown both on irrigated and rain fed areas. Wheat is grown for meeting the food demand of over growing population of the country. But its per hectare yield is below than its yield potential, which might be due to certain reasons like poor nutrients management, shortage of good quality water, poor weeds and pest management, drought, salinity and water logging. Salinity is a serious threat for wheat production in Pakistan. Wheat can be grown on all types of soils including saline soils but its yield on world scale is greatly affected by salinity. If the field salinity increases to 100 mM NaCl, rice plant will be seriously injured prior to maturity, but at the same level of salinity wheat crop will produce a reduced yield. Barley, the most salt tolerant cereal will dies at salt concentrations higher than 250 mM NaCl (Mass and Hoffman, 1977). High productivity in saline environment can be achieved through breeding of salinity tolerant crops, but success for salinity tolerant crops through breeding is limited. Crops tolerance to salinity is controlled by many genes, and their simultaneous selection is very difficult (Flowers et al., 2000).

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Tremendous efforts are required for amalgamation of desirable genes during breeding (Richard, 1996) and particularly under field conditions due to lack of efficient selection procedures (Ribaut et al., 1997). With improvement of salt tolerance in cultivated crops, diverse strategies would be available to growers resulting in more efficient practices. Reclamation of salt affecting soils includes, proper drainage system, application of irrigation water, incorporation of residues to improve water intake, allowing time for leaching, planting tolerant crops, and chemical amendments (addition of gypsum) to sodic or saline-sodic soils (Lamond and Whitney, 1992). Among the reclamation techniques, plantation of tolerant crops is most useful, as the others are expansive and difficult to be carried out. In addition, priming agents that is, $CaCl_2$, KCl, and NaCl are effective in alleviating the adverse effects of salt stress on wheat plants (Iqbal et al., 2006; Bakht et al., 2011). Pre-sowing seeds treatment with inorganic salts (halopriming) is very easy, low risk and low cost teshnique to alleviate the salinity problems of agricultural lands. The halopriming technique is very effective for improving germination and crop establishment under salt stressed conditions .Generally; seed priming increases the uniformity and rate of seed emergence of crops (Sivritepe et al., 2003; Bakht et al., 2010, 2011). Keeping in view the adverse effects of salt stress on agricultural production and to encourage the use of salt tolerant species, this present study was initiated to investigate the role of seed priming in seed vigor under saline conditions and to screen out different wheat varieties for salinity tolerance.

MATERIALS AND METHODS

This current study, for evaluation of impact of seed priming and salinity on various wheat varieties was conducted in sand culture at the greenhouse of the Institute of Biotechnology and Genetic Engineering (IBGE), Khyber Pakhtunkhwa Agricultural University Peshawar, Pakistan during winter 2008 to 2009 culture, using completely randomized design (CRD) with three replications. Seeds of different wheat varieties; Tatara-96 (T-96), Ghaznavi-98 (G-98), Fakhri Sarhad (F.Sd), Bakhtawar-92 (B-92), Pirsabaq-2004 (P-2004) and Auqab-2000 (A-2004) were first primed with saline water (30 mM NaCl) for 12 h at 25°C in case of priming. Primed (P) and unprimed (UP) seeds were grown in pots containing sand salinized with the desired NaCl levels (0, 40, 80 and 120 mM). Initially twenty seeds per pot were sown, and after complete emergence thinning was done and ten plants per pot were maintained. Half strength Hoagland solution (Hoagland and Arnon, 1950) salinized with the said NaCl levels was applied to the pots periodically. Plants were harvested 55 days after sowing. Germination percentage was calculated using the following formula:

$$\text{Germination percentage} = \frac{\text{Number of seedlings emerged}}{\text{Number of seeds sown}} \times 100$$

Days to emergence were counted from the date of sowing to the date when plants get fully emerged. To record tillers plant^{-1} data, tillers of five randomly selected plants in each treatment were counted and averaged. In case of leaves plant^{-1}, leaves of five randomly selected plants in each treatment were counted and averaged. Plant height (cm) and root length (cm) of five randomly selected plants in each treatment were measured with a ruler and then their mean value was worked out. Chloroplast pigments were isolated and estimated according to the methods of Linchtenthaler and Wellburn (1983).

Statistical analysis

Data were analyzed statistically for analysis of variance (ANOVA) following the method described by Gomez and Gomez (1984). A computer software MSTATC was used to carry out the statistical analysis. The significance of difference among means was compared by using the LSD test at $P \leq 0.05$ (Steel and Torrie, 1980).

RESULTS

Data regarding germination percentage are presented in Table 1. Statistical analysis of the data indicated that germination percentage was significantly ($P \leq 0.05$) affected by varieties, salinity and seed priming. The interactions among all possible combinations except salinity × seed priming × varieties were also significant ($P \leq 0.05$). Bakhtawar-92 exhibited the highest germination percentage of 88.75 followed by Ghaznavi-98 with germination percentage of 86.67. Pirsabaq-2004 produced lowest germination percentage (81.25). Germination percentage consistently decreased with increase in salinity from 0 to 120 mM. Maximum germination percentage (96.94) was recorded from the control followed by salinity (NaCl) level of 40 mM with germination percentages of 87.92 as compared with the minimum germination percentage of 72.92 from the treatment of 120 mM. Priming treatment significantly ($P \leq 0.05$) increased germination percentage. Maximum germination percentage of 87.50 was recorded for primed seeds when compared with germination percentage of 82.78 from unprimed seeds.

Data concerning days to emergence of wheat varieties are shown in Table 1. Statistical analysis of the data revealed that varieties, salinity and seed priming had significantly ($P \leq 0.05$) affected days to emergence of wheat crop. The interactions among salinity × priming, salinity × varieties and priming × varieties were also significant ($P \leq 0.05$). Maximum days to emergence (10.04) were recorded for Pirsabaq-2004 and Auqab-2000 (9.88 days) when compared with minimum (8.13) days to emergence from Ghaznavi-98. Increasing levels of salinity delayed emergence. Maximum 9.56 days to emergence were recorded from high salinity level of 120 mM when compared with minimum (8.42) days to emergence from control. Seed priming hastened germination with 8.01 days to emergence as compared with the treatment of no seed priming (10.26 days to emergence).

Statistical analysis of the data depicted a significant ($P \leq 0.05$) effect of varieties and salinity on plant height (cm) of wheat crop (Table 1). The interaction among salinity × variety was also significant ($P \leq 0.05$). Highest plant height (27.86 cm) was recorded from Bakhtawar-92

Table 1. Effect of salinity and seed priming on germination (%), days to emergence, plant height and root length of wheat varieties.

Variety	Germination percentage	Day to emergence	Plant height (cm)	Root length (cm)
T-96	85.83[bc]	9.42[b]	25.25[c]	16.70[c]
G-98	86.67[b]	8.13[d]	26.58[b]	17.53[b]
F. S	83.75[d]	9.00[c]	24.63[d]	16.15[d]
B-92	88.75[a]	8.38[d]	27.86[a]	18.57[a]
P-2004	81.25[e]	10.04[a]	24.02[e]	14.85[e]
A-2000	84.58[cd]	9.88[a]	23.71[e]	14.84[e]
Salinity mM				
0	96.94[a]	8.42[c]	34.75[a]	21.02[a]
40	87.92[b]	9.22[b]	28.70[b]	18.08[b]
80	82.78[c]	9.36[ab]	21.57[c]	14.76[c]
120	72.92[d]	9.56[a]	16.34[d]	11.90[d]
Seed priming				
P	87.50[a]	8.01[a]	25.43	16.50
UP	82.78[b]	10.26[b]	25.25	16.38
Interactions				
V × S	**	**	**	**
V × P	**	*	NS	NS
S × P	*	**	NS	NS
V × S × P	NS	NS	NS	NS

V: Varieties, S: Salinity, P; Primed, UP: Unprimed, NS: Non significant.
*, **Significant at 0.05 and 0.01 level of probability, respectively. Mean values of the same category followed by different letters are significant at P ≤ 0.05 level.

followed by Ghaznavi-98 and Tatara-96 with plant heights of (26.58 cm) and (25.25 cm), respectively, as compared with lowest plant height (23.71 cm) from Auqab-2000. Application of salinity to wheat crop revealed steady decline in plant height with increasing salinity levels. Mean values of the data revealed lowest plant height (16.34 cm) from 120 mM salinity when compared with 34.75 cm plant height from control. Salinity levels of 80 mM resulted to plant height of 21.57 cm, and 40 mM showed plant height of 28.70 cm and ranked 2nd and 3rd in terms of reduction in plant height. A smaller affirmative but non significant effect of seed priming on plant height was observed from the mean values of the data.

Statistical analysis of the data pertained that varieties and salinity levels had significantly ($P \leq 0.05$) affected root length (cm) of wheat crop (Table 1). Interaction among salinity × varieties was also significant ($P \leq 0.05$). The inconsistent response of varieties to application of salinity levels was evident on root length (cm). Bakhtawar-92 exhibited higher root length (18.57 cm), followed by Ghaznavi-98 (17.53 cm), while Auqab-2000 and Pirsabaq-2004 exhibited reduced root lengths of 14.84 and 14.85 cm, respectively. It is evident from the mean values that root length (cm) progressively reduced with gradual increase in salinity level. Maximum reduction in root length (11.90 cm) was observed in the treatment of 120 mM NaCl followed by the treatments of 80 mM NaCl (14.76 cm) and 40 mM NaCl (18.08 cm), respectively, when compared with maximum root length of 21.02 cm from control. The effect of seed priming was slight positive but non significant on root length (cm).

Data concerning tillers plant^{-1} of wheat as affected by seed priming and salinity are shown in Table 2. Statistical analysis of the data revealed significant ($P \leq 0.05$) effect of varieties, salinity and seed priming on number of tillers plant^{-1} of wheat crop. The interactions among salinity × seed priming, salinity × varieties and seed priming × varieties were also significant ($P \leq 0.05$). The data suggested that maximum tillers plant^{-1} (3.63) were recorded for Bakhtawar-92 followed by Ghaznavi-98 with 3.33 tillers plant^{-1} compared with lowest tillers plant^{-1} (2.57) from Auqab-2000. Exposure of wheat plants to various salinity levels showed consistent reduction in tillers plant^{-1}. Maximum tillers plant^{-1} (4.32) were recorded from control followed by salinity levels of 40 mM (3.08 tillers plant^{-1}), while minimum tillers plant^{-1} were noted in 120 mM (1.99 tillers plant^{-1}). Maximum tillers plant^{-1} of 3.07 were observed in plants from primed seeds as compared to 2.88 tillers plant^{-1} from no priming treatments.

Statistical analysis of the data also indicated that

Table 2. Effect of salinity and seed priming on tillers plant-1, leaves plant-1, shoot chlorophyll-a and shoot chlorophyll-b contents of wheat varieties.

Variety	Tillers plant-[1]	Leaves plant-[1]	Shoot chlorophyll-a contents (mg g-1 fresh weight)	Shoot chlorophyll-b contents (mg g-1 fresh weight)
T-96	2.90[c]	13.62[c]	1.08[c]	0.79[c]
G-98	3.33[b]	14.73[b]	1.12[b]	0.81[b]
F. S	2.82[d]	13.23[d]	1.07[c]	0.77[d]
B-92	3.63[a]	16.01[a]	1.15[a]	0.84[a]
P-2004	2.61[e]	12.65[e]	1.04[d]	0.65[e]
A-2000	2.57[e]	12.50[e]	1.03[d]	0.64[f]
Salinity mM				
0	4.32[a]	20.12[a]	1.30[a]	1.00[a]
40	3.08[b]	14.30[b]	1.25[b]	0.85[b]
80	2.51[c]	11.23[c]	1.01[c]	0.64[c]
120	1.99[d]	9.51[d]	0.77[d]	0.50[d]
Seed priming				
P	3.07[a]	14.25[a]	1.09	0.77[a]
UP	2.88[b]	13.33[b]	1.08	0.73[b]
Interactions				
V × S	**	**	**	**
V × P	**	**	NS	**
S × P	**	**	NS	**
V × S × P	NS	NS	NS	NS

V: Varieties, S : Salinity, P : Primed, UP: Unprimed, NS: Non significant.
** Significant at 0.01 level of probability. Mean values of the same category followed by different letters are significant at P ≤ 0.05 level.

varieties, salinity and seed priming had significantly (P ≤ 0.05) affected number of leaves plant^{-1} (Table 2). Interactions among all possible combinations except salinity × seed priming × varieties were also significant (P ≤ 0.05). Inconsistent response of varieties was observed due to application of salinity. Highest number of leaves plant^{-1} (16.01) were observed from Bakhtawar-92 followed by Ghaznavi-98 (14.73), Tatara-96 (13.62) and Fakhri-Sarhad (13.23), respectively when compared with lowest number of leaves plant^{-1} (12.50) from the treatments of Auqab-2000. The data also revealed consistent reduction in leaves plant^{-1} with exposure of plants to various salinity levels. Lowest leaves plant^{-1} (9.51) were obtained from the treatments of 120 mM (NaCl) followed by the treatments of 80 mM (11.23 leaves plant^{-1}), 40 mM (14.30 leaves plant^{-1}) as compared with maximum leaves plant^{-1} (20.12) from control. It is inferred from the data that seed priming had positively affected number of leaves plant^{-1} when compared with unprimed seeds. Primed treatments showed maximum leaves plant^{-1} (14.25) as compared to control treatments (13.33 leaves plant^{-1}).

Data relating shoot chlorophyll-a contents are presented in Table 2. Analysis of the data revealed that the effect of varieties and salinity was significant (P ≤ 0.05) on shoot chlorophyll-a contents (mg g^{-1} fresh weight). The impact of seed priming was non significant (P > 0.05) on shoot chlorophyll-a contents (mg g^{-1} fresh weight). The interaction among salinity × varieties was also significant (P ≤ 0.05). It is evident from the mean values that varieties showed changeable response in terms of chlorophyll a contents, due to application of different salinity levels. Highest shoot chlorophyll-a contents of 1.15 mg g^{-1} fresh weight plant^{-1} were recorded from Bakhtawar-92 when compared with 1.03 mg g^{-1} fresh weight of shoot chlorophyll-a contents of Auqab-2000. The data further revealed that shoot chlorophyll-a contents were progressively reduced with gradual increase in salinity level. Maximum shoot chlorophyll-a contents (1.30 mg g^{-1} fresh weight) were recorded from control when compared with 0.77 mg g^{-1} fresh weight from the treatments of 120 mM (NaCl).

Mean values of the data presented in Table 2 showed significant (P ≤ 0.05) effect of varieties, salinity and seed priming on shoot chlorophyll-b contents (mg g^{-1} fresh weight). The interactions among all possible combinations except salinity × seed priming × varieties were also significant (P ≤ 0.05). Bakhtawar-92 showed maximum shoot chlorophyll-b contents of 0.84 mg g^{-1} fresh weight plant^{-1}, and Auqab-2000 showed minimum shoot chlorophyll-b contents of 0.64 mg g^{-1} fresh weight plant^{-1}.

Mean values of the data indicated maximum shoot chlorophyll-b contents of 1.00 mg g^{-1} fresh weight from control (no salinity) and minimum shoot chlorophyll-b contents of 0.50 mg g^{-1} fresh weight from the treatments applied with 120 mM (NaCl). The effect of seed priming on shoot chlorophyll-b contents mg g^{-1} fresh weight was significant ($P \leq 0.05$). Highest shoot chlorophyll-b contents of 0.77 mg g^{-1} fresh weight were recorded from the treatment of seed priming. Whereas, minimum shoot chlorophyll-b contents of 0.73 mg g^{-1} fresh weight were recorded for unprimed treatments.

DISCUSSION

Salinity stress reduced the rate of germination due to reduced water potential and slower rate of imbibitions (Afzal et al., 2006). In this present study, it is clear that germination percentage of various wheat varieties was significantly influenced by different salinity levels and seed conditions. Our results indicate that highest germination percentage was recorded for Bakhtawar-92 followed by Ghaznavi-98. The results also indicated that germination percentage increased significantly with seed priming. Seed priming with inorganic salts showed marked increase in germination percentage of wheat genotypes (Afzal et al., 2006). The earlier and faster metabolic activities induced by seed priming causes rapid rates of radical emergence (Khan, 1992). Our results further showed that salt stress significantly increased days to emergence of various varieties, while seed priming with NaCl markedly decreased days to emergence. Our findings are in agreement with Abro et al. (2009), who reported significant increase in days to emergence of wheat due to salinity. They further suggested that seed priming with inorganic salts significantly reduced days to emergence of wheat genotypes. Decrease in days to emergence by priming might be due to rapid production of germination metabolites and better genetic repair, that is, earlier and rapid synthesis of DNA, RNA and protein (Bray et al., 1995).

Saline conditions inhibit plant growth to variable extent either by reducing plant osmotic potential or because of specific ion toxicity (Ashraf and Sarwar, 2002). In this present study, a significant reduction in plant height and root length for different wheat varieties under various seed conditions and salinity levels was observed. However, Bakhtawar-92 performed better by maintaining maximum plant height and root length, while Auqab-2000 performed poor. A little increase in the mentioned parameters was recorded in primed treatments. This decrease in plant height and root length might be due to decrease in water potential of the rooting medium due to higher ion concentration (Munns et al., 1995) and Na^+ and Cl^- accumulation to toxic level in leaves interfering metabolic processes viz. photosynthesis and protein synthesis etc, going on in cytoplasm (Ibrahim, 2003).

Higher concentration of these ions in the root zone suppressed the uptake of other essential ions like NO_3, K^+ and Ca^+ and thus resulted in reduced plant growth (Shafi et al., 2006). Significant reduction in plant height for different varieties exposed to salinity levels was also reported by Khan et al. (2007). It is evident that seed priming can increase the free radical scavenging enzymes like catalase (CAT), superoxide dismutase (SOD) and peroxidase (Chang and Sung, 1998). Improved plant vigor may be attributed to the counteraction of free radicals and the synthesis of membrane bound enzymes (Saha et al., 1990). Salt stress application had overall substantial negative effect on all visual growth parameters like shoot height and root length. However, various seed priming treatments tend to ameliorate the negative effects of salt stress (Rafiq et al., 2006).

Crop yield is generally dependent upon various yield contributing components, tillering, being the most important one. Generally, higher numbers of tillers will ensure better crop stand and high yield. The tillering capacity of crop have decreased with the application of each additional increment of salinity. Tillers plant^{-1} of different varieties were significantly affected by salinity levels and seed conditions. Bakhtawar-92 produced maximum tillers plant^{-1} as compared with Auqab-2000 with minimum tillers plant^{-1}. Seed priming with NaCl alleviated the negative impact of salinity on tillers plant^{-1}. The positive impact of seed priming was more visible on Bakhtawar-92 when compared with other varieties. Reduction in the tillering capacity of various varieties might be due to the toxic effects of salt on plant growth particularly at early growth stage. The data revealed maximum tillers plant^{-1} from tolerant varieties at all the salinity levels. Production of more productive tillers plant^{-1} may be a mechanism of salt tolerance by dilution of salts in wheat (Aslam et al., 1989). This may indicate that tillers plant^{-1} and their behavior under salt stressed conditions can be used as a simple and nondestructive measurement to evaluate wheat varieties in breeding programs. Our findings are in consistency with the results of Goudarzi et al. (2008), who reported significant reduction in tillers plant^{-1} of various wheat cultivars due to salinity. They further reported that salt tolerant cultivars were less affected when compared with salt sensitive cultivars. Seed priming with various priming agents ($CaCl_2$, KCl and NaCl) markedly reduced the impact of salinity. The impact of seed priming was more pronounced on tolerant as compared with sensitive cultivars (Iqbal and Ashraf, 2007).

Our results reveal that when various varieties were exposed to different salinity levels and seed conditions, a marked decrease in leaves plant^{-1} was observed. Bakhtawar-92 was on the top of the list for producing maximum number of leaves plant^{-1} when exposed to different salinity levels. Priming technique increased salt tolerance in various wheat varieties as evident from several parameters. Reduction in number of leaves plant^{-1}

might be due to toxic effect of salt concentration particularly at early growth stage of the crop in the growing medium and inborn genetic capabilities of various cultivars. Salt stress had negative effect on osmotic exchange between root hair and growth medium solution, because plants were unable to absorb water from the medium. Therefore, plants were unable to develop new leaves (Gorham et al., 1997). Higher salt concentration also had negative effect on certain nutrients availability to the plants and Na^+ toxic effects at high salinity levels might be also responsible for the decline in leaves plant^{-1} (Passera and Albuzio, 1997). Difference among salinity levels and cultivars was highly significant for leaves plant^{-1} (Ikramullah et al., 2005). The positive effects of seed priming relates to the suitable and efficient osmosis regulation of priming derived plants when compared with unprimed derived plants. Therefore, this trend led to an increased salinity tolerance of plants in terms of agronomic and physiological traits (Harris et al., 2001).

Photosynthetic pigments (chlorophyll a and b) of various wheat varieties were also markedly influenced by different salinity levels and seed conditions. Salinity significantly reduced photosynthetic pigments production. Different wheat varieties responded inconsistently to salinity levels in term of photosynthetic pigments. This study reveals that Bakhtawar-92 produced more, and Auqab-2000 produced less photosynthetic pigments than other varieties. These results also shows that seed priming with NaCl slightly increased chlorophyll-a production and significantly increased chlorophyll-b production. Moreover, the seed priming effect was high in tolerant varieties. Reduction in chlorophyll contents might be due to the inhibitory effects of the accumulated ions of salt on the biosynthesis of various chlorophyll fractions. Salinity impairs the strength of the forces that bring the complex pigment protein-liquid in the chloroplast structure. Since the chloroplast is membrane bounded and its stability depends on the stability of the membrane, which under high salt stressed conditions seldom remains intact because reductions in chlorophyll occurred (Ali et al., 2004). Our results are in line with Khan et al. (2010). They reported that under salt stressed conditions, the chlorophyll a and b contents of various genotypes decreased significantly. They further revealed that reduction of photosynthetic pigments was minimum in salt tolerant cultivars. Chlorophyll a and b contents of wheat crop decreased with gradual increase in salinity levels. The chlorophyll a and b contents were less affected in salt tolerant cultivar (Hossain et al., 2006). James et al. (2002) reported that photosynthesis per unit leaf area was not reduced by salt stress particularly in salinity tolerant genotypes of drum wheat. As the chlorophyll contents per unit area were higher in salt stressed conditions than control, but photosynthesis per unit area was decreased because of smaller leaves area. Salinity decreased chlorophyll a and b contents in both lines but the reduction was minimum in salt tolerant line, which could be used as criteria for selection of salt tolerant wheat. Seed priming minimized reduction of chlorophyll-a and -b. The impact of seed priming was highest in salt tolerant line (Hamid et al., 2008).

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