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RESPONSE OF WHEAT VARIETIES TO SALINITY STRESS AS AMELIORATED BY SEED PRIMING

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Abstract

Salinity is the most detrimental stress which severely inhibits development of all cultivated crops. In this experiment salinity tolerance of fourteen wheat varieties were assessed with seed priming (50 mM $CaCl_2$) and four levels of (NaCl) salinity (0, 45, 90, 135 mM). The results revealed that effects of salinity and seed priming was significant ($p \leq 0.05$) on root length, shoot and root fresh weight, shoot and root dry weight, shoot and root Na^+ content. Pirsabak-05 variety has produced maximum root length (24.12 cm), shoot dry weight plant^{-1} (2.08 g), root fresh and dry weight plant^{-1} (2.36 vs 0.47g). Maximum shoot fresh weight plant^{-1} (8.61 g) was recorded from Lalma-13. Highest root to shoot ratio was observed in wheat variety Insaf-15. Among all wheat varieties, Uqab-00 variety has accumulated highest shoot and root Na^+ content (1.31 vs 2.58 mg g^{-1} dry weight). The seed priming has enhanced root length, shoot and root fresh weight, shoot and root dry weight except shoot and root Na^+ content. Wheat varieties Pirsabak-05, Lalma-13 and Insaf-15 were more responsive to seed priming compared with Uqab-00 and Seher-06. It is concluded that wheat varieties Pirsabak-05, Lalma-13 and Insaf-15 were more tolerant to salinity compared with other varieties.

Key words: Growth characters, Seed priming, Salinity, Wheat varieties.

Introduction

Limited crop productivity is the consequence of several abiotic factors, namely drought, water logging and salinity (Dutta *et al.,* 2016). Salinity is among those abiotic stresses, which negatively influences development and yield characters of the crop (Bakht *et al.,* 2012). Salinity stress is an intense threat to agricultural productivity in arid and semi-arid region (Al-Saady, 2015). These areas are usually intercepted by low precipitation, along with elevated evapo-transpiration rate. These soils have abundance of salts in the root zones due to insufficient water for leaching (Plaut *et al.,* 2013; Akbari *et al.,* 2013). Pakistan is the 8th nation in term of area (6175 thousand ha.) influenced by salinity (Anon., 2015). The development of salt tolerant varieties is the feasible option besides costly reclamation of saline soil to get maximum yield (Kokten *et al.,* 2010). Salinity initially exerts osmotic effect on plant physiology at cellular and at whole plant level, and plant development is reduced by deleterious impact of salinity (Collado *et al.,* 2016). The plants utilizes diverse mechanism under saline conditions to cope with adverse conditions, (Khan *et al.,* 2008) i.e. maintaining higher chlorophyll content, proline content and K^+/Na^+ ratio (Khan *et al.,* 2007). The tolerant plants have the capability to withstand high salt concentration and to complete their life cycle (Parvaiz & Stayawati, 2008). Several morpho-physical changes happen in plants as indicator of salt tolerance. The plant responses to salinity depend on varieties, species, stage of plant growth and organ of the plants exposed to salinity (Parvaiz & Stayawati, 2008). To screen varieties for salinity tolerance these variations in adaptive mechanism of salinity-exposed plants are utilized as salt tolerance characteristics (Nasim *et al.,* 2007). The performance of plants in saline growth environment has shown positive outcome with seed priming with salts (Afzal *et al.,* 2008a). The fundamental goal of seed priming treatment is to set up plants that withstand abiotic stresses and to reduce time required from sowing to development. Seed priming initiate the metabolic events appeared after imbibitions stage, which are utilized to mitigate the negative impact of salinity (Aymen & Cherif, 2013). Salt tolerance of cultivated wheat varieties were successfully improved by seed priming with $CaSO_4$ and $CaCl_2$salts (Farooq *et al.,* 2008). In order to minimize the harmful effect of salt stress and to increase the cultivation of salt tolerant varieties the current research was conducted to verify the response of various cultivated wheat varieties to seed priming and salinity.

Materials and Methods

The experiment was conducted at the Institute of Biotechnology and Genetic Engineering (IBGE), The University of Agriculture Peshawar, Pakistan. In this experiment fourteen wheat varieties were primed with 50 mM $CaCl_2$ (un-primed used as control) which were exposed to 0, 45, 90, 135 mM NaCl salinity levels. Seeds of different varieties of wheat (Lalma-13, Shahkar-13, Pirsabak-13, Insaf-15, Barsat-10, Atta-Habib-10, Siran-10, Bathoor-08, Pirsabak-08, Seher-06, Pirsabak-05, Saleem-00, Uqab-00 and Inqilab-91) were soaked for 12 hours in a solution of 50 mM $CaCl_2$ at room temperature. Twenty seeds of these varieties were sown in pots containing washed sterilized sand, which was salinized with 0, 45, 90, 135 mM NaCl. Ten plants were maintained in each pot after emergence. All nutrients were applied in the form of half strength Hoagland solution (Hoagland & Arnon, 1950). The pH of Hoagland solution was regularly maintained between 6.0-6.5. The plants were harvested after 50 days of sowing. Three plants were randomly selected for measurement of root length. Thereafter, to record shoot and root fresh weight (g plant^{-1}), shoots and roots from each treatment were separated and weighed on electronic balance. These samples were separately dried for 48h in oven at 80°C, and again weighted to obtain shoot and root dry weight (g plant^{-1}). The root to shoot ratio was calculated by dividing root dry weight by shoot dry weight. Dried samples of shoot and root were grounded, powdered and further subjected for shoot and root Na^+ analysis. The flame photometer (Jenway PFP-7) was calibrated against standard solution of Na^+ (Benton *et al.*, 1991).

Statistical analysis: The data was analyzed statistically by MSTATC computer software (Russel & Eisensmith, 1983) according to the appropriate procedure used for randomized complete block design with split plot arrangement. Least significant difference test ($p \leq 0.05$) was applied in case of significant F-test for mean comparisons (Steel & Torrie, 1997).

Results

Root length (cm): The root length of wheat varieties was influenced significantly ($p \leq 0.05$) at all salinity levels (Table 1). The main effects of seed priming and interaction combination were non-significant except variety and salinity interaction. Wheat varieties Pirsabak-05 and Lalma-13 have produced highest root length (24.12 cm vs 22.66 cm), while variety Uqab-00 recorded lowest root length (14.67 cm). Uplifting salinity stress from 90 to 135 mM salinity has severely reduced root length by 27.17% and 37.71% respectively. This study revealed less reduction in root length by imposition of salinity stress in Pirsabak-05 (tolerant variety), while root length of sensitive wheat variety (Seher-06) has suffered highest reduction with application of highest salinity (135 mM NaCl) (Fig. 1).

Table 1. Root length (cm), shoot and root fresh weight (g plant^{-1}) and shoot dry weight (g plant^{-1}) of wheat varieties as affected by salinity and seed priming.

Varieties	Root length (cm)	Shoot fresh weight (g plant^{-1})	Root fresh weight (g plant^{-1})	Shoot dry weight (g plant^{-1})
Lalma-13	22.66b	8.61a	2.19b	2.00b
Shahkar-13	21.22c	7.94d	2.05c	1.89c
Pirsabak-13	19.72d	7.82e	1.97d	1.86d
Insaf-15	21.43c	8.22c	2.17b	1.89c
Barsat-10	17.53f	7.38g	1.76f	1.77g
Atta-Habib-10	18.60e	7.51f	1.84e	1.81ef
Siran-10	17.06g	7.31g	1.61g	1.70h
Bathoor-2008	18.56e	7.02h	1.82e	1.79fg
Pirsabak-08	19.63d	7.63f	1.94d	1.82e
Seher-06	15.49i	6.72j	1.34i	1.51j
Pirsabak-05	24.12a	8.38b	2.36a	2.08a
Saleem-00	16.52h	7.01h	1.59g	1.70h
Uqab-00	14.67j	6.66j	1.53h	1.54i
Inqilab-91	16.70gh	6.85i	1.58g	1.69h
			Salinity (mM)	
0	23.16	9.63	2.49	2.30
45	20.96	8.12	2.01	1.96
90	16.86	7.05	1.67	1.58
135	14.42	5.22	1.19	1.32
			Seed priming	
Un-primed	18.82	7.36	1.78	1.72
Primed	18.88	7.65	1.90	1.86
Significance for P	ns	s	s	s
$LSD_{(0.05)}$ for V	0.366	0.118	0.035	0.025
$LSD_{(0.05)}$ for S	0.195	0.063	0.019	0.013
			Interactions	
V x P	ns	s	s	s
P x S	ns	s	s	s
V x S	s	s	s	s
P x S x V	ns	s	s	s

*, ** =Significant at 5%and 1% probability level, V = Varieties, P = Seed priming, S = Salinity, ns =Not significant, Means represented by common letters are not significantly different at ($p \leq 0.05$)

Shoot fresh weight (g plant^{-1}): The shoot fresh weight was significantly ($p \leq 0.05$) affected by salinity levels, while seed priming has ameliorative effect on wheat varieties (Table 1). The significant ($p \leq 0.05$) interactions combinations were observed for shoot fresh weight. Maximum shoot fresh weight of 8.61and 8.38 g plant^{-1} was recorded from Lalma-13 and Pirsabak-05 varieties however, minimum shoot fresh weight of 6.66 g plant^{-1} was observed in Uqab-00 variety. The seed priming in comparison with no seed priming was proved beneficial and increased shoot fresh weight by 3.84%. Decreasing trend was observed in shoot fresh weight due to increasing salinity stress. Gradual downfall of 15.66% was observed with salinity level of 45mM and further decrease of 26.75% and 45.80% was the consequence of 90, and 135 mM NaCl salinity. Seed priming at several salinity stresses has indicated highest shoot fresh weight, however, lowest shoot fresh weight was the consequence of no seed priming at highest salinity (Fig. 2). Seed priming has an ameliorative impact on shoot fresh weight of salt tolerant wheat variety (Lalma-13) compared with shoot fresh weight of salt sensitive variety (Uqab-00) with no seed priming (Fig. 3). Shoot fresh weight was reduced with elevating salinity stress compared with shoot fresh weight of wheat varieties observed at control salinity (Fig. 4).

Root fresh weight (g plant^{-1}): The salinity levels have significantly ($p \leq 0.05$) affected root fresh weight of wheat varieties, however seed priming has ameliorated the root fresh weight of wheat varieties. Interaction combination of seed priming, varieties and levels of salinity were significant ($p \leq 0.05$). The root fresh weight was maximum in wheat variety Pirsabak-05 (2.36 g plant^{-1}) and Lalma-13 (2.19 g plant^{-1}), while minimum root fresh weight of 1.34 g plant^{-1}was observed from Seher-06. In response to salinity, root fresh weight was dropped down by 19.41% at 45 mM salinity, 32.96% at 90 mM salinity and 52.04% at 135 mM salinity. The seed priming has profound effect on root fresh weight obtained from both saline and non-saline medium, however, improvement of root fresh weight was more remarkable from primed seed (Fig. 5). The seed priming of tolerant variety (Pirsabak-05) has showed more root fresh weight compared with salt sensitive variety (Seher-06) with no seed priming (Fig. 6). The salt sensitive wheat varieties (Seher-06, and Uqab-00) when exposed to highest salinity level (135 mM NaCl) has accumulated less root fresh weight, however, improved root fresh weight was recorded from tolerant wheat variety (Pirsabak-05) raised in control salinity growth medium (Fig. 7).

Shoot dry weight (g plant^{-1}): The shoot dry weight was significantly ($p \leq 0.05$) variable in response of seed priming, varieties and salinity stress levels (Table 1). The interactions of salinity levels, seed priming and varieties were significant ($p \leq 0.05$). Among all wheat varieties, Pirsabak-05 and Lalma-13 have produced highest shoot dry weight of 2.08 and 2.00 g plant^{-1}respectively. The shoot dry weight of 1.89 g plant^{-1} was observed in Shahkar-13 and Insaf-15 varieties. Across all wheat varieties, Seher-06 recorded minimum dry weight of shoot (1.51 g plant^{-1}). The shoot dry weight was more in primed seed by 7.73% when compared with un-primed seed (1.86 vs 1.72 g plant^{-1}). The elevation in salinity level by 45 and 90 mM has resulted reduction of 14.54% and 31.25%, while further increase in salinity with 135 mM has caused greater decrease of 42.74% in shoot dry weight. The seed priming technique has produced highest shoot dry from each increasing salinity level, when compared with no seed priming (Fig. 8). The wheat varieties Pirsabak-05, Insaf-15 and Lalma-13 were more responsive to seed priming treatment than rest of the varieties (Fig. 9). In saline conditions, Lalma-13 and Pirsabak-05 varieties have maintained highest shoot dry weight compared with other varieties, (Fig. 10).

Root dry weight (g plant^{-1}): The root dry weight of all wheat varieties was decreased significantly with elevated salinity levels, however, seed priming has relieved the impact of salinity. The interaction combination for root dry weight was significant ($p \leq 0.05$). Maximum root dry weight of 0.47 and 0.46 g plant^{-1} was recorded in Pirsabak-05 and Lalma-13 varieties respectively, while minimum root dry weight of 0.25 g plant^{-1} was observed in variety Seher-06. The improvement in shoot dry weight was observed in response to seed priming (0.37 g plant^{-1}) than un primed seed (0.33 g plant^{-1}). The reduction in root dry weight was highest (52.88%) at 135 mM salinity, while reduction of 18.54%, and 37.17% was recorded from salinity level of 45 and 90 mM respectively. The seed priming was proved effective by improving the root dry weight in saline and non-saline treatment (Fig. 11). Maximum increase in root dry weight was recorded in tolerant variety (Pirsabaq-05) when exposed to seed priming (Fig. 12). Highest root dry weight was produced by variety Pirsabak-05 in control. The varieties (Seher-06 and Uqab-00) have maintained lowest root dry weight at highest level of salinity (Fig. 13).

Root to shoot ratio: Salinity stress levels have induced significantly ($p \leq 0.05$) variable root shoot ratio in varieties of wheat, however, seed priming has improved root shoot ratio (Table 2). The interaction of seed priming and salinity was non-significant. The maximum root shoot ratio (0.24) was produced by variety Insaf-15, while root shoot ratio (0.23) was recorded from Lalma-13 and Pirsabak-05 varieties. In the treatment of seed priming, 4.89% increase was noticed in root shoot ratio, in comparison with control. Substantial reduction of 20.20% 9.52 %, 5.61% in root shoot ratio was resulted from salinity level of 135, 90, 45 mM NaCl respectively. The root to shoot ratio of wheat varieties were consistently enhanced with seed priming than no seed priming, however, wheat varieties (Pirsabak-08, Pirsabak-05) have maintained highest root shoot ratio than rest of varieties (Fig. 14). Increasing salinity increments has dropped down root to shoot ratio of wheat varieties. The susceptible varieties have suffered remarkable loss with additional salinity increments except tolerant varieties (Insaf-15, Pirsabak-05), where root shoot ratio was maximum compared with sensitive varieties (Seher-06, Uqab-00) (Fig. 15). The study indicated minimum reduction in root to shoot ratio from primed seeds of tolerant wheat varieties (Pirsabak-05, Pirsabak-08, Insaf-15) when exposed to elevating level of salinity. However, salt sensitive wheat varieties (Uqab-00, Seher-06) have suffered maximum reduction with application of elevating salinity level.

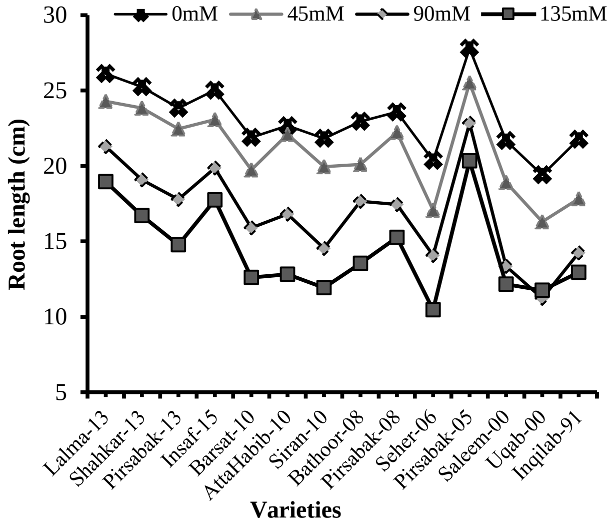

Fig. 1. Interaction of varieties and salinity for root length (cm).

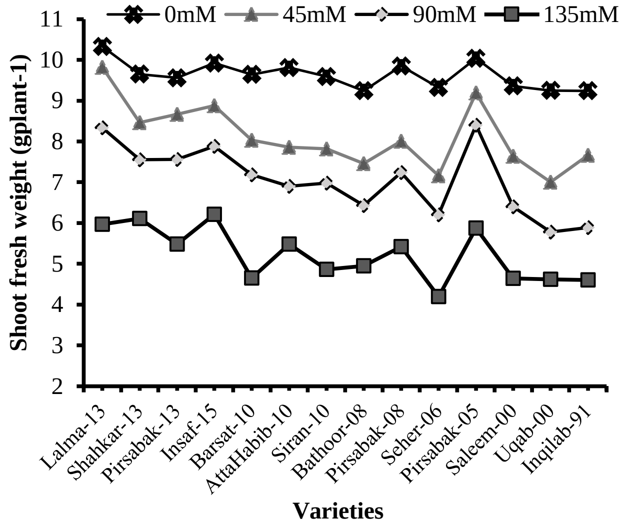

Fig. 4. Interaction of varieties and salinity for shoot fresh weight (g plant^{-1}).

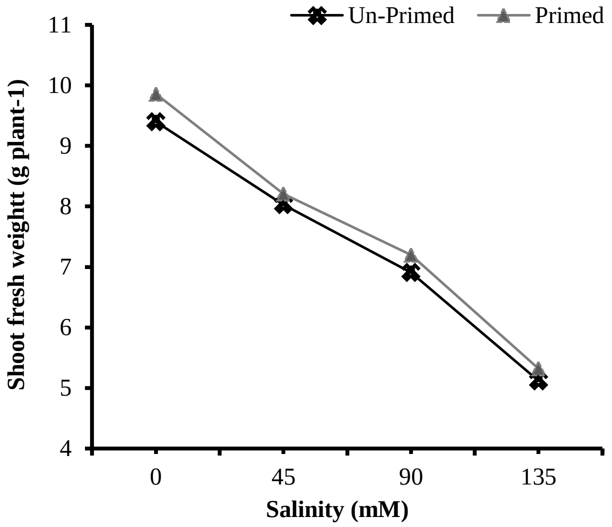

Fig. 2. Interaction of seed priming and salinity for shoot fresh weight (g plant^{-1}).

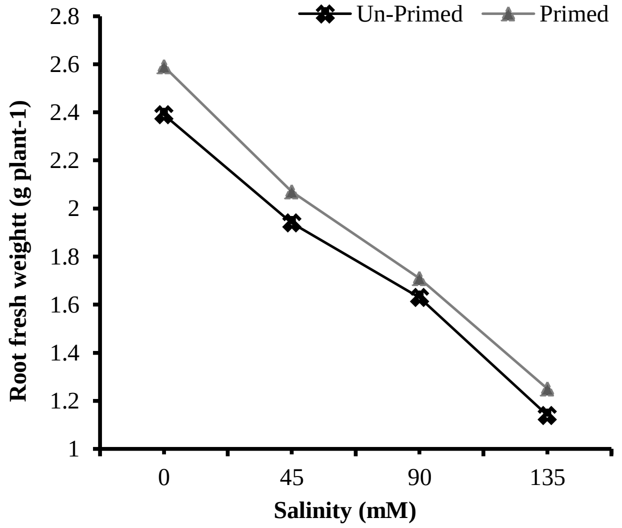

Fig. 5. Interaction of seed priming and salinity for root fresh weight (g plant^{-1}).

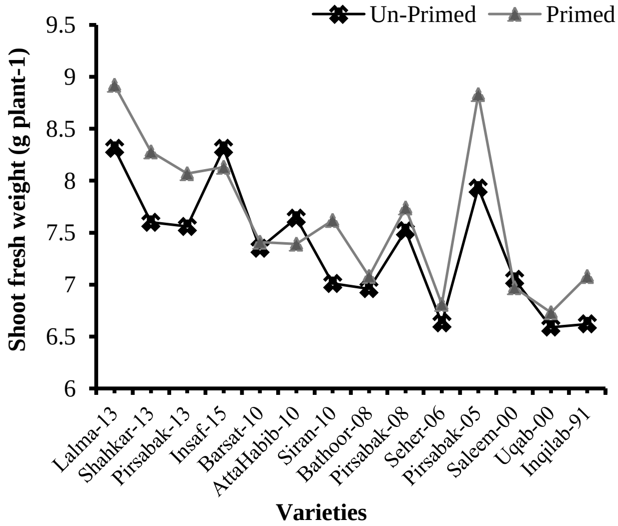

Fig. 3. Interaction of seed priming and varieties for shoot fresh weight (g plant^{-1}).

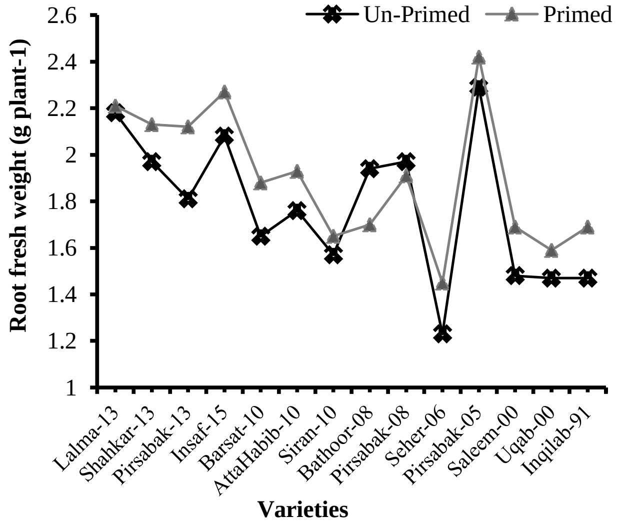

Fig. 6. Interaction of seed priming and varieties for root fresh weight (g plant^{-1}).

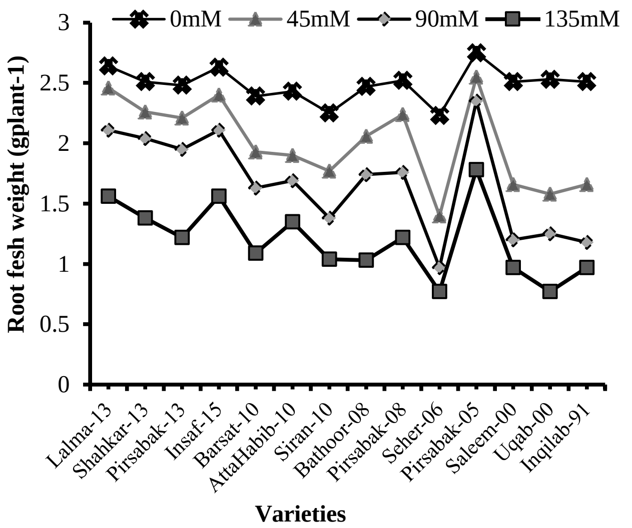

Fig. 7. Interaction of varieties and salinity for root fresh weight (g plant^{-1}).

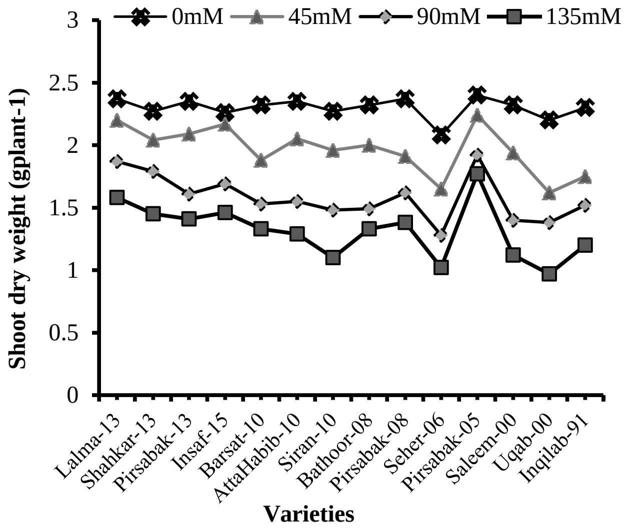

Fig. 10. Interaction of varieties and salinity for shoot dry weight (g plant^{-1}).

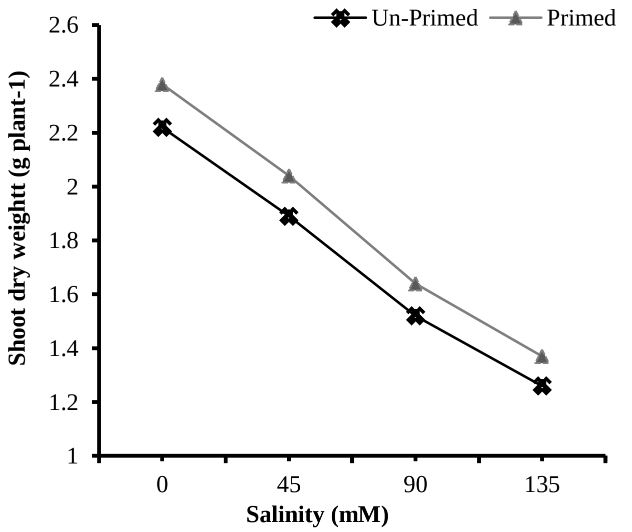

Fig. 8. Interaction of seed priming and salinity for shoot dry weight (g plant^{-1}).

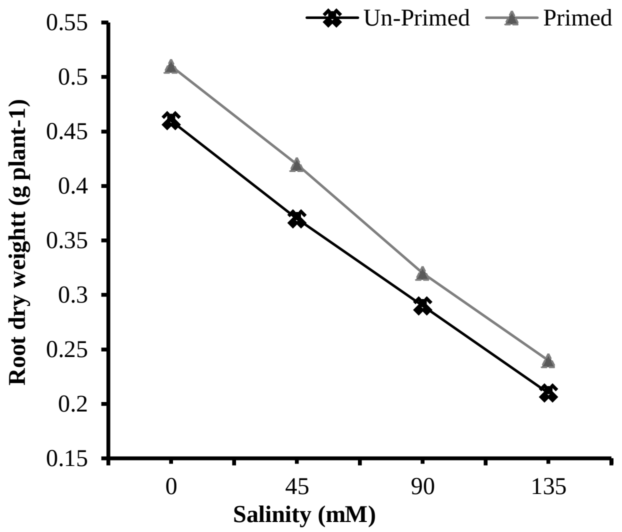

Fig. 11. Interaction of seed priming and salinity for root dry weight (g plant^{-1}).

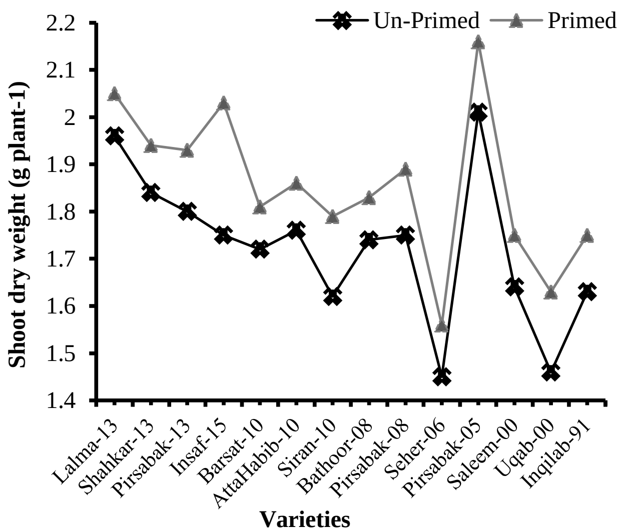

Fig. 9. Interaction of seed priming and varieties for shoot dry weight (g plant^{-1}).

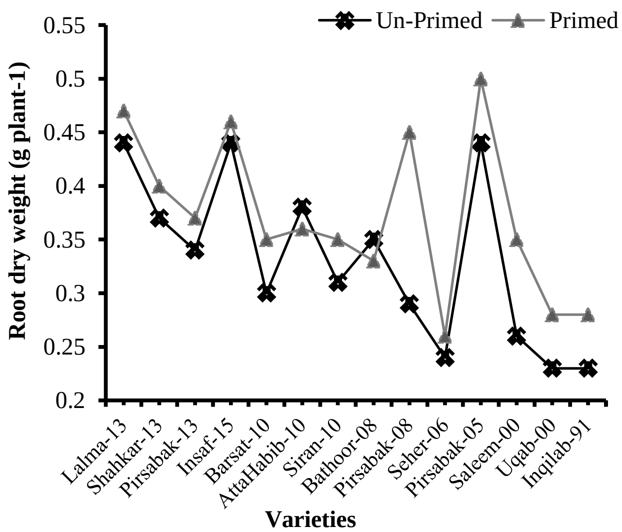

Fig. 12. Interaction of seed priming and varieties for root dry weight (g plant^{-1}).

Table 2. Root dry weight (g $plant^{-1}$), root to shoot ratio, shoot and root Na^+ content (mg g^{-1} dry weight) of wheat as affected by salinity and seed priming.

Varieties	Root dry weight (g $plant^{-1}$)	Root to shoot ratio	Shoot Na^+ content (mg g^{-1} dry weight)	Root Na^+ content (mg g^{-1} dry weight)
Lalma-13	0.46b	0.23b	0.95k	2.23i
Shahkar-13	0.39d	0.20c	1.01i	2.32g
Pirsabak-13	0.36f	0.19d	1.02h	2.37f
Insaf-15	0.45c	0.24a	0.97j	2.30gh
Barsat-10	0.33h	0.18e	1.10f	2.44cd
Atta-Habib-10	0.37e	0.20c	1.07g	2.43de
Siran-10	0.33h	0.19d	1.13e	2.46c
Bathoor-2008	0.34g	0.19d	1.10f	2.43cde
Pirsabak-08	0.37e	0.20c	1.07g	2.41e
Seher-06	0.25j	0.16g	1.27b	2.51b
Pirsabak-05	0.47a	0.23b	0.95k	2.29h
Saleem-00	0.30i	0.17f	1.21d	2.49b
Uqab-00	0.26j	0.16g	1.31a	2.58a
Inqilab-91	0.26j	0.15h	1.23c	2.50b
		Salinity (mM)		
0	0.48	0.21	0.40	0.63
45	0.39	0.20	1.09	2.37
90	0.30	0.19	1.39	2.75
135	0.23	0.17	1.52	3.89
		Seed priming		
Un-primed	0.33	0.19	1.11	2.44
Primed	0.37	0.20	1.09	2.38
Significance for P	s	s	s	s
$LSD_{(0.05)}$ for V	0.007	0.004	0.011	0.027
$LSD_{(0.05)}$ for S	0.004	0.002	0.006	0.014
		Interactions		
V x P	s	s	s	s
P x S	s	ns	s	ns
V x S	s	s	s	s
P x S x V	s	s	s	ns

*, ** = Significant at 5% and 1% probability level, V = Varieties, P = Seed priming, S = Salinity, ns =Not significant
Means represented by common letters are not significantly different at ($p \leq 0.05$)

Shoot Na^+ content (mg g^{-1} dry weight): The data reveals that main effects and interactions of seed priming, salinity stress for varieties were significant ($p \leq 0.05$) for shoot Na^+ content (Table 2). Variety Uqab-00 was highest accumulator of shoot Na^+ content (1.31 mg g-1 dry weight) and varieties Pirsabak-05 and Lalma-13 have absorbed lowest Na^+ content (0.95 mg g^{-1} dry weight) in shoot. Sodium accumulation in shoot was 2.56% least in treatment of primed seed compared with control. Sodium storage in shoot (1.09, 1.39, 1.52 mg g^{-1}) was drastically increased at 45, 90, 135mM salinity. In comparison with control, seed priming has lowered the absorption of Na^+ with elevating salinity stress (Fig. 16). Seeds of Pirsabak-05 and Lalma-13 varieties when primed have reduced the accumulation of sodium content of shoot. The Uqab-00 variety with no seed priming has shown elevated content of shoot Na^+ content (Fig. 17). Application of each uplifting level of salinity to wheat varieties Pirsabak-05 and Lalma-13 has indicated lowest uptake of shoot sodium (Fig. 18). Application of varying levels of salinity and priming treatment of tolerant varieties such as Pirsabak-05, Insaf-15 and Lalma-13, have shown least uptake of shoot Na^+.

Root Na^+ content (mg g^{-1} dry weight): Table 2 reveals that several wheat varieties when exposed to seed priming have shown variable and significant ($p \leq 0.05$) response to varying levels of salinity. The interaction of varieties and seed priming, varieties and salinity was significant. The root Na^+ content (2.58 mg g^{-1}) was highest in Uqab-00 variety, and minimum root Na^+ content of 2.23 mg g^{-1} was observed in Lalma-13. The accumulation of Na^+ content in root was lowest in treatment of seed priming by 2.32% than control. The gradual rise in salinity stress levels (45, 90, and 135 mM NaCl) has caused drastic elevation in root Na^+ content by 276.43%, 336.73% and 518.19% respectively. The no seed priming of varieties (Uqab-00 and Seher-06) have recorded highest Na^+ content of root, however, least accumulation of Na^+ was observed in varieties Lalma-13 and Pirsabak-05 (Fig. 19). Tolerant varieties Pirsabak-05, Lalma-13 and Insaf-13 have maintained lowest root sodium content even at higher salinity levels (Fig. 20).

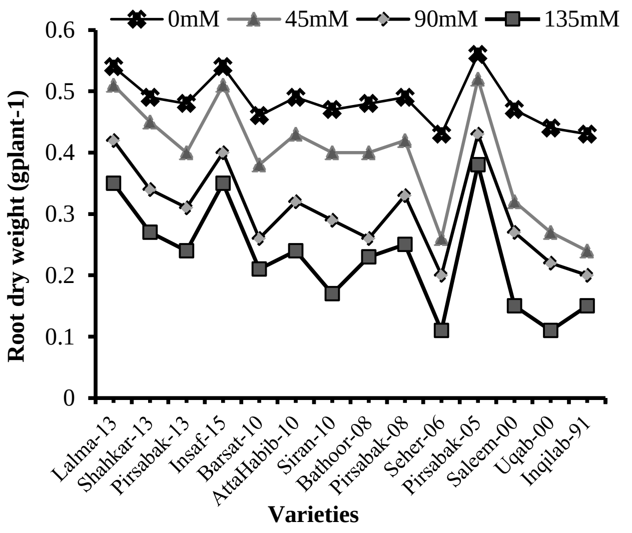

Fig. 13. Interaction of varieties and salinity for root dry weight (g plant^{-1}).

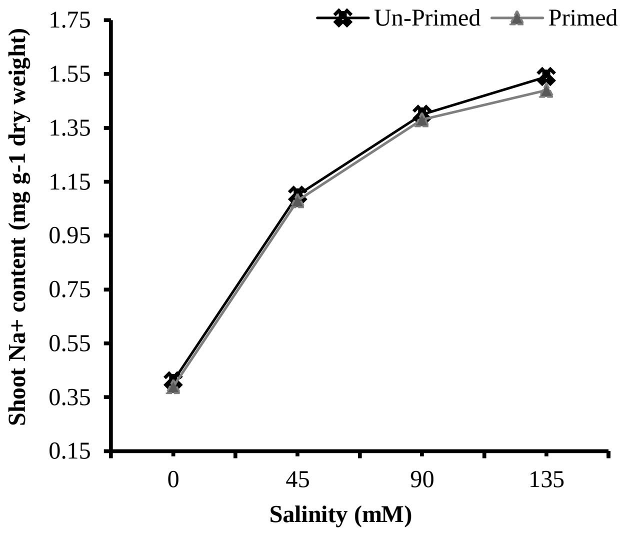

Fig. 16. Interaction of seed priming and salinity for shoot Na+ content (mg g-1 dry weight).

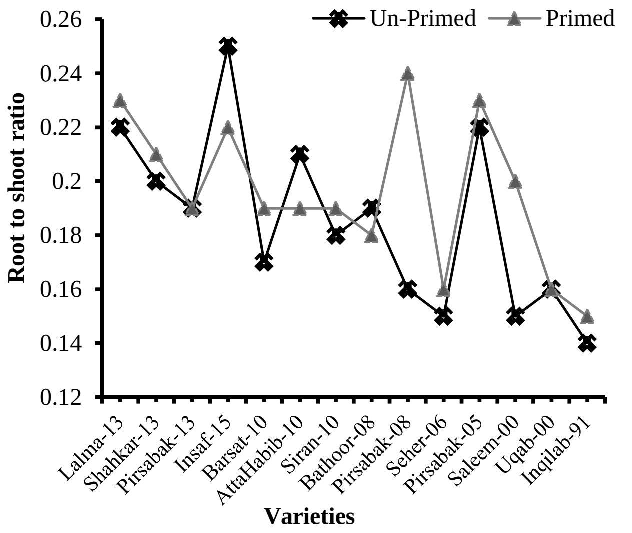

Fig. 14. Interaction of seed priming and varieties for root shoot ratio.

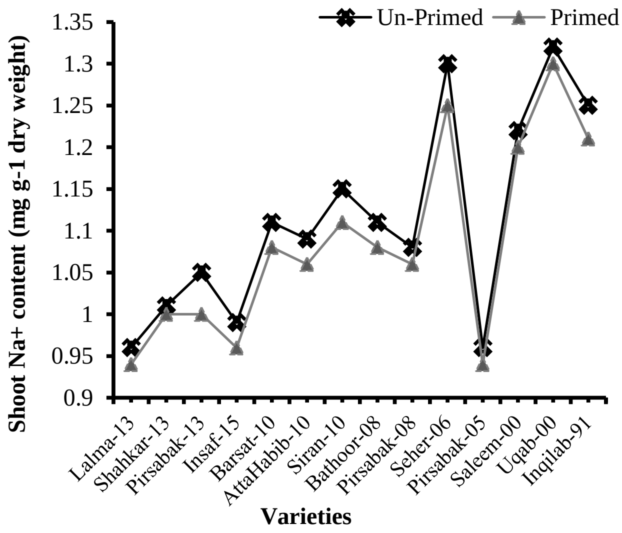

Fig. 17. Interaction of seed priming and varieties for shoot Na+ content (mg g-1 dry weight).

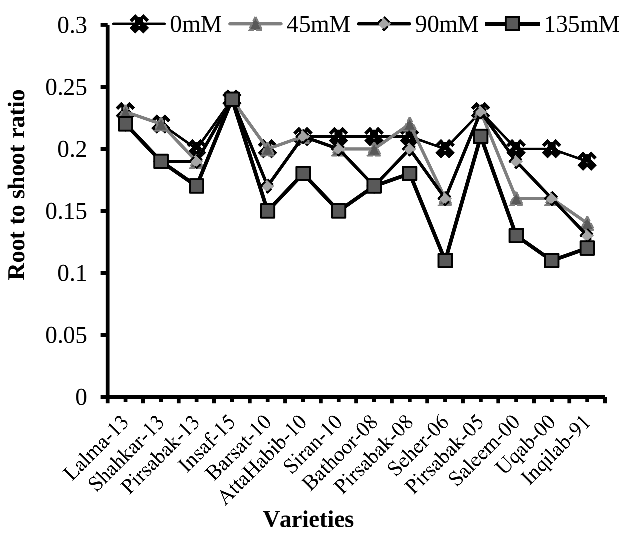

Fig. 15. Interaction of varieties and salinity for root to shoot ratio.

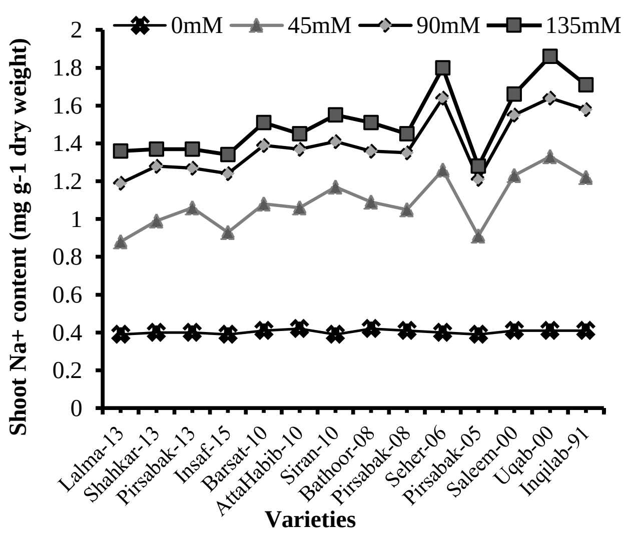

Fig. 18. Interaction of varieties and salinity for shoot Na+ content (mg g-1 dry weight).

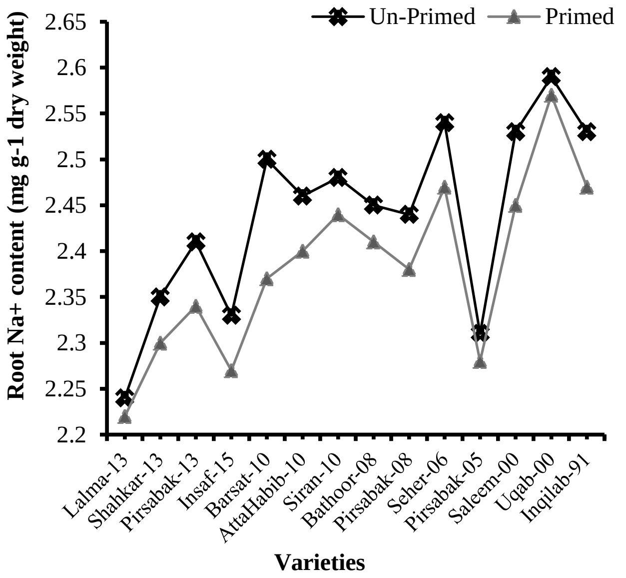

Fig. 19. Interaction of seed priming and varieties for root Na+ content (mg g-1 dry weight).

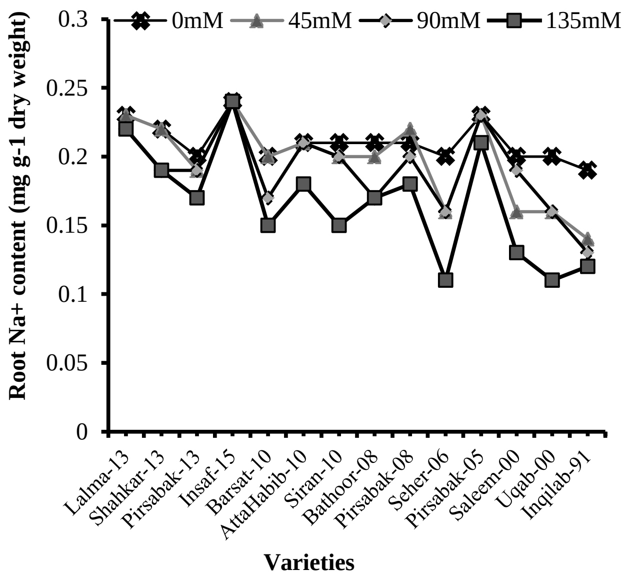

Fig. 20. Interaction of varieties and salinity for root Na+ content (mg g-1 dry weight).

Discussion

In arid and semi-arid region of the world (Akca & Samsunlu, 2012) salinity is the dominant abiotic stress that adversely affects all growth stages and final crop yield (Bakht *et al.,* 2012). To assess salinity stress tolerance of wheat varieties, several physiological and agronomic characters are used. Environmental factors on plant growth influence multi-genetic factors that in combination define agronomic traits (Oyiga *et al.,* 2016). Aymen *et al*., (2012) investigated that crop yield and agronomic traits in saline stress was efficiently improved by seed priming. Shoot and root growth are important characters that determine tolerance or sensitivity of a plant. In the current study deeper root system was observed in wheat varieties Pirsabak-05 and Lalma-13 and Insaf-15 (salt tolerant) while Uqab-00, Seher-06 and Inqilab-91 (salt sensitive) varieties produced shallow root system. It has been reported that for crop establishment, proper root development is very essential for wheat crop (Raziuddin *et al.,* 2010). PEG induced drought stress and reduced the development of shoot and root growth (Sattar *et al.,* 2015). In comparison with control treatment, seed priming has improved the length of root as reported by Cha-um *et al*., (2012).

Wheat varieties have showed variable trend in shoot fresh and dry weight with imposition of salinity stress. Greater shoot fresh and dry biomass was observed in Pirsabak-05 and Lalma-13 (tolerant varieties), in comparison with lowest shoot fresh and dry of variety Uqab-00 (salt sensitive). The low magnitude of light interception due to high salt stress was due to physiological drought (Imran *et al.,* 2016). This study has confirmed that seed priming has enhanced shoot fresh and dry weight in both normal and saline growth environment. The $CaCl_2$ affects seed vigor, which resultantly has improved the performance of salt tolerant varieties (Tamimi, 2016). Morphological parameters including shoot biomass of wheat varieties studied by Yusuf *et al*., (2012) were increased by seed priming in saline condition.

Remarkable variations were observed in root fresh and dry weight of varieties in response to salinity stresses. The wheat variety (Uqab-00) has indicated greater reduction pattern, however, varieties (Pirsabak-05 and Lalma-13) have showed least reduction in root fresh and dry weight. The experimental results indicated that at each elevating level of salinity, root fresh and dry weight was decreased gradually, as reported by findings of Silini *et al*., (2016). In saline condition, reduction in thickness, density and volume of roots was due to ionic toxicity, water deficiency and unavailability of photosynthates to the roots (Shafi *et al.,* 2010). Seed priming has enhanced root fresh and dry weight of wheat varieties when exposed to saline conditions. The hydro-priming in comparison with no seed priming has produced more root fresh and dry weight. Root biomass was greater with longer root system from treatments of seed priming with $CaCl_2$and $CaSO_4$ (Afzal *et al.,* 2008b). The salt tolerant variety (Pirsabak-05) has efficiently maintained greater root shoot ratio across all wheat varieties. However, salt sensitive varieties Inqilab-91, Seher-06 and Uqab-00 have produced minimum root shoot ratio. Khan *et al*., (2011) reported that tolerant wheat varieties keep up highest root growth and root shoot ratio. The root to shoot ratio was significantly enhanced by seed priming. The salinity levels has decreased root shoot ratio, however, seed priming with $CaCl_2$ has produced highest root shoot ratio (Dugasa *et al.,* 2016). The results of seed priming technique have indicated significant improvement in root to shoot ratio in saline environment. The successful germination is ensured with seed priming which provide hydration to seed and initiate set of biochemical events (Jabbarpour *et al.,* 2012). The rapid germination and uniform stand establishment could be achieved by seed priming, because, such seeds have the support of all required metabolic process (Musa & Lawal, 2015).

The findings pertaining to shoot and root Na^+ of wheat varieties have explored variable response from salinity levels and seed priming. The wheat varieties

(Uqab-00 and Seher-06) which showed sensitivity to salinity have absorbed and retained greater magnitude of salts. Lowest absorption of shoot and root sodium was observed in tolerant varieties (Pirsabak-05 and Lalma-13). The salt susceptible varieties have maintained greater quantity of Na^+ as reported by Yusuf *et al*., (2012). The abundance of sodium plays an important role due to excess absorption of heavy metals such as cadmium (Shafi *et al.,* 2011). It is evident from our results that seed priming was the efficient technique to reduce the absorption and retention of Na^+ content by plants. The injurious impacts of salinity on soils are over accumulation of salts that can be ameliorated by seed priming. Moreover, the positive effect of seed priming with $CaCl_2$ in salt stressed situation could be due to role of calcium (Ca^{++}) in stress identification and signaling mechanism, as well as to minimize entry of sodium in cells of plant (Cha-um *et al.,* 2012).

Conclusion

The application of different salinity levels have reduced root length, fresh weight of shoot and root, root to shoot ratio and shoot and root dry weight of wheat varieties. The adverse impact of salinity was relieved by seed priming with $CaCl_2$. The variable response with improvement in morphological characteristics and shoot and root sodium reduction was recorded among various varieties due to seed priming technique. Saline stress was mitigated with ameliorative effect of seed priming in wheat varieties (Pirsabak-05, Insaf-15 and Lalma-13) compared with wheat varieties (Inqilab-91 and Uqab-00 and Seher-06). The wheat varieties (Pirsabaq-05, Lalma-13 and Insaf-15) have showed better performance compared with other varieties. It is concluded that seed priming with $CaCl_2$ was successful treatment to relieve the antagonistic influence of salt stress on growth attributes of wheat varieties.

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