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# INFLUENCE OF SALT STRESS ON GROWTH AND BIOCHEMICAL PARAMETERS OF WHEAT (*Triticum aestivum* L.)

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## ABSTRACT

**Soil salinity is a major abiotic stress in agriculture, keeping this view an experiment was conducted in the Department of Crop Physiology C. S .Azad University of Agriculture and Technology, Kanpur during 2007-08. Four levels of (NaCl) salt treatments i.e. 3, 6, 9 and 12 dsm1, simultaneously in addition to control and eight genotypes of wheat viz. KRL1-4, K8434, K88, K9644, K9465, K9006, HD 2733 and HD 2329. In response to salt stress growth parameters such as plant height, number of tiller per plant and dry weight reduced at increasing levels of salt stress. The high salt concentration caused a great reduction in nitrate reductase activity, potassium content and sodium potassium ratio. With increasing the levels of salinity proline and sodium accumulation was increased. However, yields are reduced with increasing levels of salinity. Genotypes K 9006, KRL1-4, K8434, HD 2329, HD 2733 and K88 showed better performance in all the regard. Genotypes K9644 and K9465 showed sensitive to salt stress.**

***Key words :*** *Wheat, salt stress, wheat growth, biochemical.*

Plant bend toward many adaptive strategies in response to differing abiotic stresses such as salinity, water logged, water stress, cold, heat etc. Among these salinity is one of the major abiotic stresses, which adversely affect the plant growth and yield (1). Salinity is the buildup of soluble salts by which saline soil are formed (2). Salinity may be due to many reasons but some of the adverse effects of salinity have been attributed to increase in chlorides and sodium ion (3). NaCl salt enhances the osmotic potential of soil matrix as a result of which water intake by plants is restricted (4).

Wheat is the second important food crop (after rice) in India. Northern India is best suited for wheat production. About 90 per cent of the total wheat production is contributed by five states mainly U.P., Punjab, Haryana, M.P. and Rajasthan (5). Salinity effects the growth and development of the plant. Wheat is more tolerant at germination stage but highly sensitive to salinity at later stage (6). Salinity reduced plant height, tillers numbers and dry weight (7). Enzymes activity like aspertase, aminotransferase, and alanine transferase and glutathione dehydrogenase are increased by salinity (8). Proline and sodium content increased with increasing salinity (7). Reduction in nirate reductase activity, potassium content and sodium potassium ratio (8).

Population of India is increasing day by day. So to feed this population, there is dire need to utilize the saline area for crop production. To achieve optimal food production in saline regions, the most appropriate and logical choice is growing salt tolerant genotypes which are best suited for this region.

## MATERIALS AND METHODS

Eight wheat genotypes ( KRL1-4, K8434, K88, K9644, K9465, K9006, HD 2733 and HD 2329) differing in their tolerance to salinity were evaluated at different levels of salt stress i.e. EC 3,6,9 and 12 ds/m in addition to control. Soils samples are collected from Experimental Research Farm Nababganj, Kanpur. The samples are air-dried, pulverized and sieved in laboratory to make homogenous mixture.120 clay pots of 12 inch size were selected and thoroughly washed. The inner portion of pot was lined with polythene sheet to check loss of water. Pots are divided in to 24 groups for five treatments including control. The pot is arranged to completely randomized design with three replicate of each treatment. A basal dose of N at 100 mg/kg as urea, $P_2O_5$ at 90 mg/kg as single super phosphate and

K at 120 mg/ kg as potassium sulphate were mixed in to soil prior to seed sowing. The remaining N was applied after first irrigation. In each pot 15 seeds were shown and thinned to five uniform plants/pot after seedling emergence at crown root stage.

Plant height is measured in centimeters from the base of stem to the top most leaf with the help of meter scale. The total number of tillers was counted which emerged out from the tagged mother plant. The oven dried samples were weighed separately and dry matter content of whole plant was weighed in electrical balance to the milligram. All the plants from each pot were harvested, and left for sun drying. After threshing samples, grain yield per plant was recorded on average basis.

The proline in leaves was estimated according to the method used by (9). A homogenized fresh leaf tissue (0.5 g) was added in 10 ml. of 3% sulfo-salicylic acid. Homogenates the leaves samples were filtered through Whatman NO-2 filter paper 2 ml. of filtrate was taken in a test tube containing 2 ml. of acid ninhydrin in 30 ml. Glacial acetic acid and 20 ml. of 6 M orthophosphoric acid. Then 2 ml. of glacial acetic acid was added in a test tube containing filterate and heated for 1 h at 100°C. Test tube was then shifted in an ice bath to terminate the reaction. Reaction mixture was then extracted with 10 ml. toluene and mixed vigorously by passing a continuous air stream for 1-2 minutes. Toluene was aspirated from chromophore. Aqueous phase was separated, warned at room temperature and absorbance was noted at 520 nm, while toluene was used as a blank. Proline concentration was determined from a slandered curve and calculated on fresh weight basis as follow:

(Mole Proline/g fresh weight = proline (g)/m x ml of toluene/115.5) (g of sample/5)

Nitrate reductase activity is measured according to method given by (10).

200 mg of leaves of each sample are sliced in to 2-3 mm fragments and placed in a light proof serum vial, in which 5 ml. of assay mixture is already placed. The vials are incubated in dark at 30°C for 30 minutes. Nitrate formed is estimated by adding 1 ml of 1% sulphanilamide and 1 ml. of 0.02 % NED to 1 ml. of assay mixture after incubation. The absorbance of the pink colour developed, is measured at 540 nm in spectrophotometer. The enzyme activity is estimated in term of nitrate (m $NO_2$) produced per gram fresh weight of leaf tissue per hour.

Enzyme activity = m $NO_2$ g FW/hr

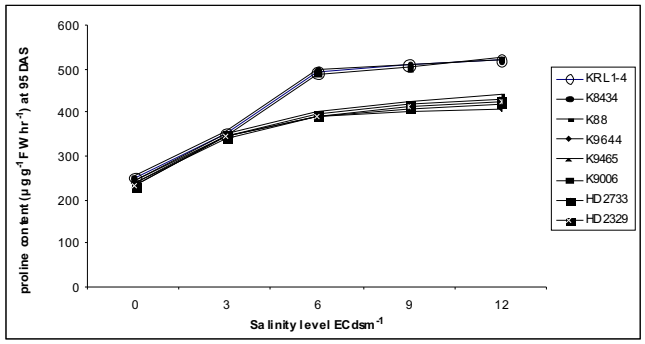
The concentration of nitrate is calculated by calibration curve prepare by using sodium nitrate solution as a standard. Sodium and potassium content in grain are estimated by flame photometer as described in U.S.D.A. Handbook No. 60 (1954).10 ml. of well mixed grains is taken and it is digested with con. Nitric acid till white residue on drying left. After that, samples are dissolved in Con. HCl and warm distilled water and after filtration the final volume is made up 10 ml. This solution is automized in flame photometer and the concentration of sodium and potassium are d determined with the help of calibration curve and the results are expressed in percentage.

## RESULTS AND DISCUSSION

Application of salt to wheat genotypes at 3 ds/m had no adverse effect rather it proved better among all the levels of salinity. Plant height (Table-1) increased by salinity up to the level of 3 ds/m, beyond that a significant reduction was noted by 33% at 25 DAS, 23% at 75 DAS and 22% at 90 DAS. Among varieties lesser reduction was noted in K9006, K8434, K88 and KRL1-4 over other varieties. Minimum plant height was recorded in variety K9644. The tiller production per plant (Table-1) was minimum at 25 DAS thereafter, it increased up to 75 DAS after that it was reduced. Level of salinity from up to 6sd/m to 12ds/m showed a significant reduction by 28%, 22% and 23% at various stages of growth. Variety K9006 showed maximum tiller production followed by KRL1-4, K8434, K88 and HD 2733, while the lowest tiller was observed in K9644. Dry weight was minimum at 25DAS and maximum at 90 DAS. The total dry weight (Table-1) increased about seven times from 25-75 DAS and two times from 75-90 DAS. Increase the level of salinity > 3 ds/m showed a drastic reduction at 25DAS (28%), at 75 DAS (29%) and at 90 DAS (28%).Variety K9006 accumulate maximum dry weight, while variety K9644 showed poor performance. Grain yields (Table-1 and Fig. 6) are decreased by 40% with increasing levels of

**Table-1 :** Effect of salt on plant height, tiller number dry weight and grain yield in different genotypes of wheat.

| Genotypes/Salt levels (EC ds/m) | Plant height (cm) DAS | | | Tiller Numbers DAS | | | Dry weight (g) DAS | | | Grainyield DAS |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | 75 | 90 | 25 | 75 | 90 | 25 | 75 | 90 | 120 |
| **KRL 1-4** | | | | | | | | | | |
| control | 6.8 | 66.10 | 67.10 | 3.0 | 4.3 | 3.7 | 0.178 | 3.27 | 9.80 | 6.86 |
| 3 | 7.0 | 68.00 | 68.60 | 3.3 | 4.5 | 4.0 | 0.188 | 3.40 | 10.97 | 7.80 |
| 6 | 6.5 | 62.10 | 64.20 | 2.8 | 4.2 | 3.5 | 0.138 | 2.70 | 8.48 | 6.42 |
| 9 | 5.8 | 45.50 | 60.10 | 2.3 | 3.9 | 3.3 | 0.127 | 2.35 | 6.40 | 5.38 |
| 12 | 4.3 | 42.40 | 56.20 | 2.1 | 3.2 | 2.9 | 0.080 | 1.58 | 4.40 | 4.20 |
| Mean | 6.08 | 56.82 | 63.24 | 2.70 | 4.02 | 3.48 | 0.142 | 2.66 | 8.01 | 6.13 |
| **K8434** | | | | | | | | | | |
| Control | 6.8 | 64.70 | 72.20 | 3.0 | 4.2 | 3.7 | 0.180 | 3.24 | 10.30 | 7.48 |
| 3 | 7.2 | 65.50 | 74.10 | 3.3 | 4.5 | 3.9 | 0.195 | 3.75 | 11.20 | 8.22 |
| 6 | 6.5 | 56.50 | 64.40 | 2.8 | 4.3 | 3.0 | 0.140 | 2.85 | 9.10 | 6.75 |
| 9 | 5.7 | 52.10 | 64.00 | 2.4 | 3.7 | 3.2 | 0.125 | 2.35 | 7.30 | 5.22 |
| 12 | 4.8 | 48.00 | 49.00 | 2.0 | 2.9 | 2.8 | 0.070 | 1.70 | 4.20 | 4.30 |
| Mean | 6.2 | 57.36 | 64.14 | 2.66 | 3.92 | 3.32 | 0.142 | 2.77 | 8.42 | 6.34 |
| **K88** | | | | | | | | | | |
| Control | 7.0 | 65.10 | 71.10 | 2.9 | 4.2 | 3.6 | 0.168 | 3.15 | 10.20 | 6.68 |
| 3 | 7.2 | 67.10 | 73.20 | 3.1 | 4.4 | 3.8 | 0.170 | 3.35 | 11.35 | 7.60 |
| 6 | 6.2 | 60.50 | 62.40 | 2.7 | 4.1 | 3.1 | 0.137 | 2.65 | 8.40 | 6.40 |
| 9 | 5.6 | 45.20 | 58.00 | 2.2 | 3.8 | 3.1 | 0.119 | 2.30 | 6.30 | 5.48 |
| 12 | 4.0 | 41.80 | 50.00 | 2.0 | 3.0 | 2.7 | 0.097 | 1.65 | 3.60 | 4.35 |
| Mean | 6.0 | 44.50 | 62.94 | 2.66 | 3.90 | 3.26 | 0.139 | 2.62 | 7.97 | 6.10 |
| **K9644** | | | | | | | | | | |
| Control | 6.0 | 56.25 | 63.40 | 2.5 | 4.3 | 3.6 | 0.170 | 3.32 | 10.00 | 7.10 |
| 3 | 6.4 | 57.30 | 64.80 | 2.7 | 4.5 | 3.8 | 0.173 | 3.35 | 11.10 | 7.45 |
| 6 | 5.5 | 51.40 | 57.80 | 2.1 | 3.2 | 2.8 | 0.125 | 2.40 | 7.30 | 5.44 |
| 9 | 4.6 | 43.70 | 49.50 | 1.7 | 2.5 | 2.3 | 0.105 | 1.87 | 5.40 | 3.18 |
| 12 | 3.1 | 40.50 | 45.30 | 1.5 | 2.1 | 1.9 | 0.078 | 1.31 | 3.90 | 2.40 |
| Mean | 5.10 | 49.83 | 56.16 | 2.0 | 3.32 | 2.88 | 0.130 | 2.45 | 7.54 | 5.11 |
| **K9465** | | | | | | | | | | |
| Control | 7.1 | 56.25 | 60.30 | 2.6 | 4.2 | 3.7 | 0.171 | 3.18 | 10.12 | 6.97 |
| 3 | 7.3 | 57.30 | 61.50 | 2.8 | 4.3 | 3.9 | 0.173 | 3.45 | 11.10 | 7.38 |
| 6 | 6.1 | 51.40 | 57.40 | 1.9 | 3.5 | 2.9 | 0.120 | 2.50 | 7.60 | 5.24 |
| 9 | 4.7 | 43.70 | 53.50 | 1.7 | 2.9 | 2.3 | 0.109 | 1.85 | 5.50 | 3.37 |
| 12 | 3.2 | 40.50 | 48.70 | 1.2 | 2.2 | 1.7 | 0.088 | 1.35 | 3.60 | 2.65 |
| Mean | 5.68 | 49.83 | 56.28 | 2.04 | 3.42 | 2.9 | 0.132 | 2.46 | 7.58 | 5.12 |
| **K9006** | | | | | | | | | | |
| Control | 7.0 | 60.20 | 73.20 | 3.1 | 4.4 | 3.8 | 0.174 | 3.25 | 10.32 | 7.20 |
| 3 | 7.3 | 61.40 | 75.10 | 3.3 | 4.6 | 3.9 | 0.184 | 3.80 | 12.10 | 8.10 |
| 6 | 6.7 | 58.10 | 65.50 | 2.9 | 4.2 | 3.7 | 0.148 | 2.90 | 9.20 | 6.20 |
| 9 | 5.5 | 56.10 | 60.50 | 2.1 | 3.8 | 3.2 | 0.129 | 2.45 | 6.00 | 5.98 |
| 12 | 5.2 | 51.10 | 48.10 | 2.0 | 3.1 | 2.7 | 0.090 | 1.80 | 5.15 | 4.70 |
| Mean | 6.34 | 57.38 | 64.48 | 2.68 | 4.02 | 3.46 | 0.145 | 2.84 | 8.55 | 5.29 |
| **HD2733** | | | | | | | | | | |
| Control | 5.9 | 61.50 | 72.10 | 3.0 | 4.0 | 3.5 | 0.155 | 3.35 | 10.60 | 7.00 |
| 3 | 6.1 | 62.70 | 73.70 | 3.2 | 4.2 | 3.7 | 0.180 | 3.42 | 11.60 | 7.80 |
| 6 | 5.8 | 58.00 | 66.60 | 2.6 | 3.9 | 3.1 | 0.135 | 2.60 | 6.85 | 6.30 |
| 9 | 5.6 | 44.20 | 51.20 | 2.2 | 3.7 | 3.0 | 0120 | 2.20 | 5.35 | 5.30 |
| 12 | 5.0 | 41.40 | 46.70 | 1.9 | 3.1 | 2.6 | 0.095 | 1.48 | 3.70 | 3.15 |
| Mean | 5.84 | 53.56 | 62.06 | 2.58 | 3.78 | 3.18 | 0.137 | 2.84 | 7.62 | 5.91 |
| **HD 2329** | | | | | | | | | | |
| Control | 6.9 | 56.25 | 68.30 | 2.7 | 4.6 | 3.9 | 0.168 | 3.30 | 10.32 | 7.20 |
| 3 | 7.1 | 57.30 | 69.50 | 2.9 | 4.7 | 4.3 | 0.175 | 3.35 | 11.29 | 7.70 |
| 6 | 6.5 | 51.40 | 63.10 | 2.0 | 3.7 | 3.1 | 0.140 | 2.60 | 7.28 | 5.34 |
| 9 | 4.9 | 43.70 | 50.40 | 1.8 | 2.8 | 2.5 | 0.105 | 1.91 | 5.40 | 3.58 |
| 12 | 3.3 | 40.50 | 46.30 | 1.6 | 2.2 | 2.1 | 0.085 | 1.28 | 3.60 | 2.65 |
| Mean | 5.74 | 49.83 | 59.50 | 2.22 | 3.6 | 3.8 | 0.134 | 2.48 | 7.57 | 5.29 |
| S | 0.16 | 1.15 | 1.07 | 0.12 | 0.16 | 1.80 | 0.0042 | 0.123 | 0.31 | 0.281 |
| G | 0.21 | 1.45 | 1.36 | 0.16 | 0.21 | 0.22 | 0.0053 | 0.155 | 0.40 | 0.355 |
| CD at 5% (S x G) | 0.47 | 3.26 | 3.04 | 0.35 | 0.48 | 0.51 | 0.0119 | 0.348 | 0.89 | 0.795 |



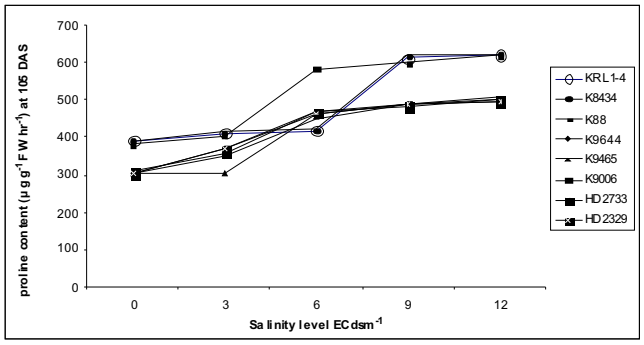
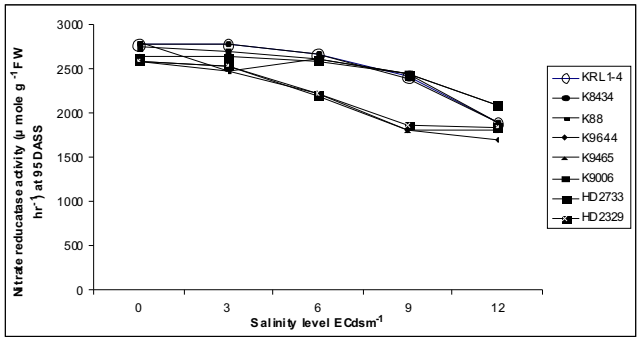




**Fig. 1 :** Effect of salt on proline content in different genotypes of wheat



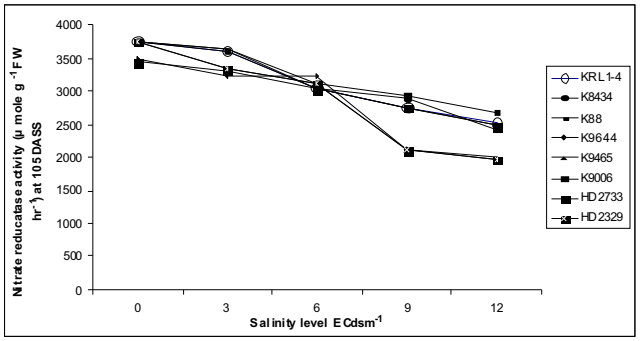




**Fig. 2 :** Effect of salt on nitrate reductase activity content in different genotypes of wheat

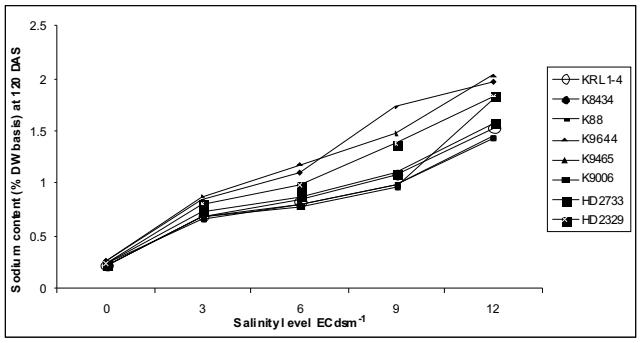



**Fig. 3 :** Effect of salt on sodium content in different genotypes of wheat.

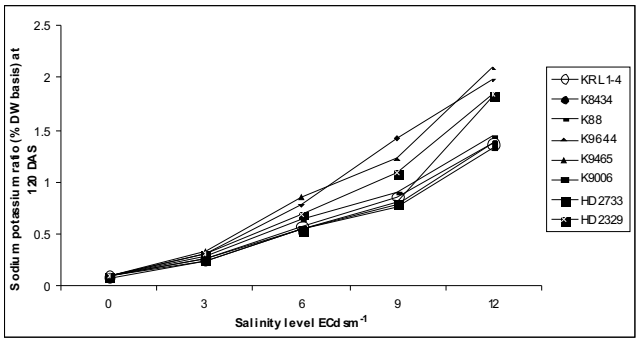



**Fig. 4 :** Effect of salt on potassium content in different genotypes of wheat.

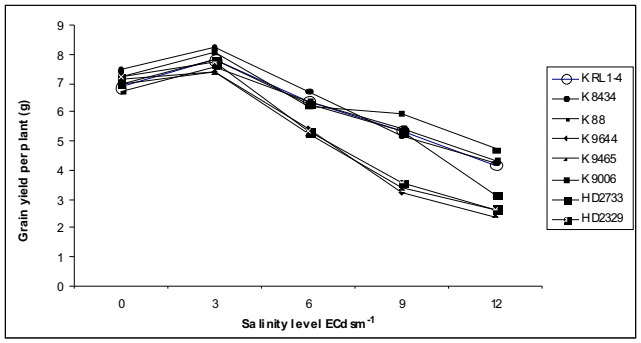



**Fig. 5 :** Effect of salt on sodium potassium ratio in different genotypes of wheat.

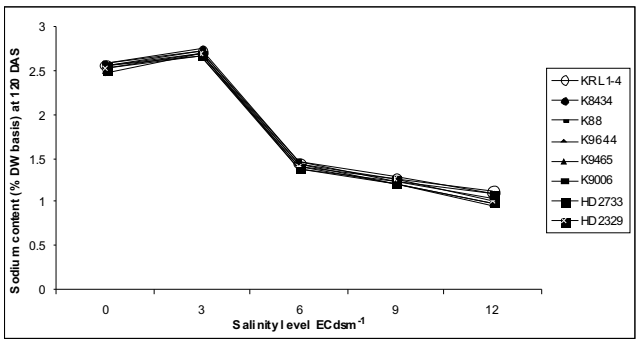



**Fig. 6 :** Effect of salt on grain yield (g) in different genotypes of wheat.

salinity. Maximum grain yield was recorded in variety K9006 followed by K8434, K88, KRL1-4 and HD 2733. However, variety K9644 showed lowest grain production.

Adverse effect of salinity on the above parameter might be due to lesser absorption of water and nutrient from the growing media due to higher concentration of salt present in the root zone, which may causes imbalances in osmotic pressure. Reduced growth under salt stress might be due to reduced transport of essential nutrient to the shoot. (11). Salinity reduced cell division and cell elongation. Higher Salinity retarded the synthesis of auxin (12). Similar finding reported by (13). Plant height, stem diameter and plant biomass decreased with increasing levels of saline water (7). Decline in dry matter accumulation in Suaeda nudiflora by 7.5 ECe levels of saline water irrigation (14). Salinity directly inhibit cell division and cell enlargement, which results in reduction of shoot length, number of leaves, leaf area, which affect the mobilization of food material from source to sink. Salt stress of EC 6 and 10 ds/m decreased grain yield in wheat (15).

Salt tolerant genotypes can be minimized salt uptake, potential salt load per unit new growth and provide water use efficiency. Tolerant genotypes had a capability to better nutrient and water absorption capability which provide maximum leaf area that resulting in better accumulation of photo-assimilate in plant. Reduction in biomass increased with salinity, because it disturbs the physiological and osmotic adjustment (16).

Biochemical Parameters: application of salt to wheat genotypes at 3 ds/m had no adverse effect rather it proved better among all the levels of salinity. Increasing levels of salinity increased accumulation of proline (Fig. 1) by 32% (at 95 DAS) and 30% (at 105), sodium (Fig. 3) by 54% (at 120DAS) and sodium potassium ratio (Fig. 5) by 59% (at 120 DAS), while nitrate reductase activity (Fig. 2) decrease by 22% (at 95 DAS) and 24% (at 105DAS). However, potassium accumulation (Fig. 4) decrease by 62% (at 120 DAS).Maximum value of proline, NR-activity and potassium content was noted in variety K9006 followed by K8434, KRL1-4, K88 and HD 2733. Variety K9006 showed minimum value of these parameters. However, variety K9644 gave minimum value.

Effects of salinity on above parameters seem to be due to reduction in enzymatic activities, auxin synthesis, proline accumulation in leaves. Reduced protein and enzymatic activities (*e.g.* nitrate reductase activity, aspertase, and aminotransferase and glutathione dehydrogenase) with increasing salt stress (17). Salinity changes the levels of plant hormones such as abscissic acid and cytokinin (18). Salinity enhanced proline accumulation, lipid peroxidation and ethylene levels in plant (19). Reduction in DNA, RNA, and soluble protein and enhancement in peroxidase and proline with increasing levels of salt stress (8). Increased $Na^+/K^+$ ratio might be due to excess accumulation of sodium in the root zone which affects the cationic imbalances caused by high osmotic pressure. Salt stress increase accumulation of sodium. (20). Potassium content decreases under saline condition (14).

Salt tolerant genotypes may accumulate more proline, ABA and potassium and lower sodium. To maintained better nutrition N, P and K provide against tolerance. Maximum accumulation of potassium maintained ionic balances which provide criteria for salt tolerance. Tolerant genotypes of wheat accumulate higher potassium and lower sodium (21). Reduced $Na^+$ and enhanced $K^+$ accumulation provide tolerance under saline condition (16). (22) reported that salinity enhanced NR-activity and proline accumulation in tolerant varieties. ABA accumulation in leaves was higher under salinity stresses which provide better protection against oxidative stress (23).

The assessment of the effect of salinity on the growth and biochemical attributes in wheat genotypes lead us to conclude that all the considered parameters were significantly affected by salt stress .The results of this study are in accordance with earlier reports which show that in response to osmotic stress, the synthesis of compatible organic solutes occurs in favour the hypothesis that proline act protective compound and higher potassium sodium ratio provide during salt stress. These organic solutes and ionic balances could be used as a biochemical marker for assessing salt tolerance in wheat.

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