Effect of salinity on Na+ and K+ compartmentation in salt tolerant and sensitive wheat genotypes

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Introduction

Effect of salinity on plant growth combined osmotic stress, ion toxicity and mineral deficiency. (Hasegawa et al., 2000); (Munns, 1993); (Munns, 2002); (Neumann, 1997); (Yeo, 1998). Salt stress in soil or water is one of the major stresses especially in arid and semi-arid regions and can severely limit plant growth and productivity (Allakhverdiev et al., 2000); (Koca et al., 2007). Higher concentration of sodium (Moradi and Ismail, 2007); (Tester and Davenport, 2003) and Cl^- (Shabala et al., 2000) and lower concentrations of K^+ (Flowers and Hajibagheri, 2001) were announced in plant tissue due to salinity. This study investigated the distribution pattern of ions in different tissues and the effect of salinity on selective transfer of Na^+ and K^+. This study was carried out on 20 wheat genotypes with different salt tolerance levels.

Method

20 different wheat genotypes were planted in the same conditions (12 dSm^{-1}). The selective criterions for tolerant genotypes were higher plant dry weight and K^+ / Na^+ ratio. Seed were planted in normal and salinity condition (12dSm^{-1}).

Normal clay sandy loam soil was passed through 2.5 mm sieve and salinized with calculated amount of NaCl salt to develop level of salinity (12 dS m^{-1}) while control has the same ECe as that of original soil. The filled pots were arranged in randomized complete design (CRD) with 3 replications and 20 different wheat genotypes as a factorial experiment and irrigated with tap water having an electrical conductivity (EC) 0.4 dS m^{-1}.

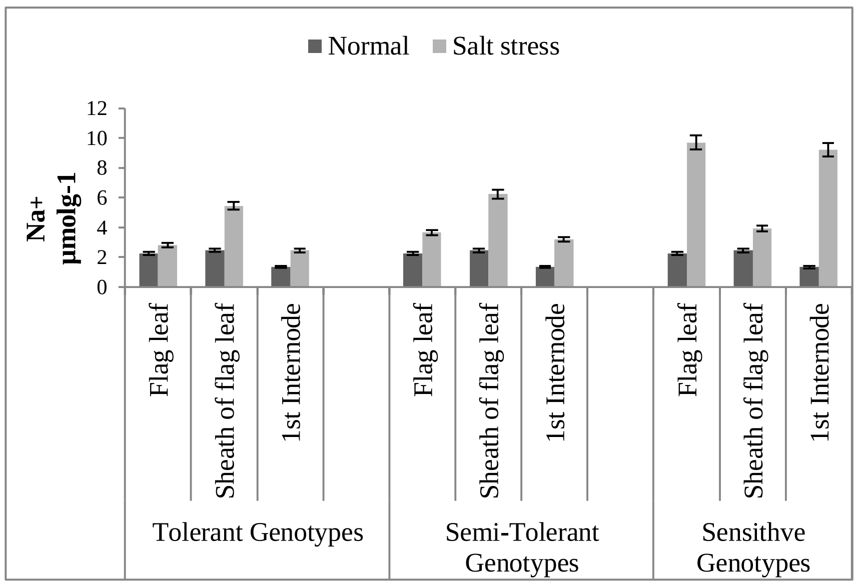
Results

Statistical analysis of the data revealed that Na^+ concentration in different tissues was significantly ($p<0.01$) affected by various genotypes of wheat and different soil condition and their interactions. The results of this case were showed that the highest amount of Na^+ was in tolerant and semi- tolerant genotypes relating to root and flag leaf sheath with mean of 5.75 (number of 16, 398DH) in root and 5.45 $\mu molg^{-1}$ concentration in tolerant genotypes in flag leaf sheath and 4.45 (number of 18, 386DH) in root and 6.23 $\mu molg^{-1}$ in semi-tolerant in flag leaf sheath (figure 1) and the lowest concentration of Na^+ related to flag leaf and the first inter node with mean of 2.82 and 2.46 $\mu molg^{-1}$ concentration in tolerant and 3.66 and 3.20 $\mu molg^{-1}$ concentration in the semi-tolerant genotypes.

Salt stress significantly ($P<0.01$) caused a reduction of K^+ concentration. Interactions of genotype and salinity were statistically significant at 1% level of probability. Due to the antagonistic properties of Na^+ and K^+ with salt increase, K+ rate decreased in all tissues, but this reduction was different in genotypes. So that in first internode the highest amount of K^+ was related to tolerant and semi-tolerant genotypes with 27 % and 31% reduction compared to normal condition and lowest amount was related to sensitive genotype with 54% reduction compared to normal condition.

The results of analysis of variance showed that salinity had a significant effect ($P<0.01$) on the ratio of potassium to sodium in all of tissues. Interactions of genotype and salinity were significant at %1 level of probability.

The analysis of data of genotypes in salinity showed with increasing of salinity, the ratio of K^+ to Na^+ decreased in all tissues. The highest ration of K^+ to Na^+ related to tolerant cultivars and the lowest was related to sensitive genotypes. In tolerant and semi tolerant genotypes under stress conditions, the minimum ratio of K^+/ Na^+ was related to root with ratio of 0.16 (number of 7, 64S) and 0.25 (number of 6, 164S) respectively. Also the highest proportion in tolerant genotype related to the first inter node and flag leaf at the ratio of 2.1 and 1.66, and in the semi-tolerant genotype with ratio of 1.11 and 1.56 in the stress conditions, but in leaves and roots of sensitive genotype, it had the lowest ratio of 0.18 and 0.17 in stress condition.



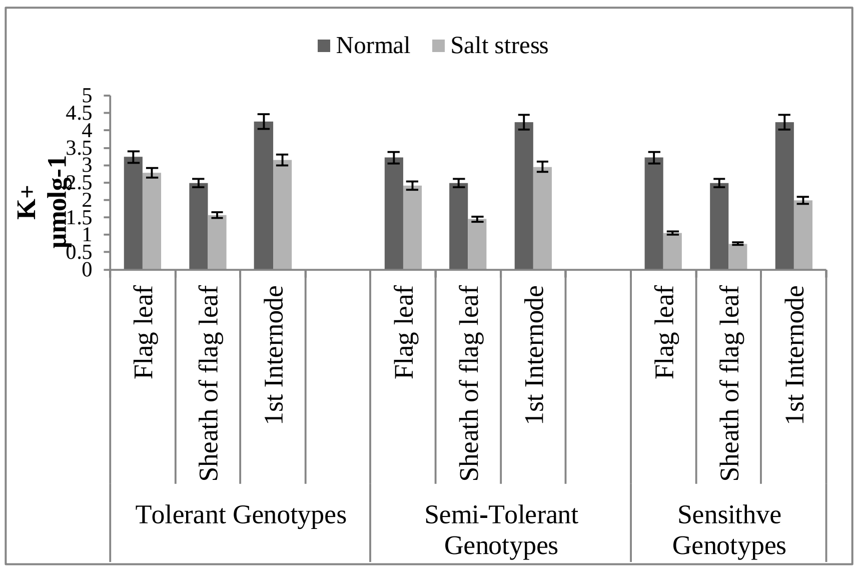


Figure 1. **Na^+** and **K^+ content in different issues in wheat genotypes**

Discussion

However, the accumulation with higher values of Na^+ in roots and leaf sheath in comparison with leaves is one of the tolerance mechanisms in grasses, and in plants, one of the determining factors in salt tolerance is to limit the transport of sodium ions into photosynthetic cells and the growing of meristem active tissue. The maintenance of ions in the leaf sheath tissue and excretion of sodium from leaf protect sensitive photosynthetic tissue against the possible effects caused by ion toxicity. Based on the results of this experiment, sodium ion preferentially will accumulate in root and leaf sheath with high concentration, and no high accumulation of sodium ions in young leaves of tolerant genotypes expresses that root and leaf sheath respectively acted as the major obstacles to prevent the transfer of sodium ions to shoot and leaves act (Netondo et al., 2004); (Huang et al., 2006); (James et al., 2006); (Davenport et al., 2005). These results are similar to those of (Ashraf and Khanum, 2000) in which they found that salt tolerance of wheat cultivars was associated with low transport of Na^+.

References

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