Effect of Silicon on Salt Tolerance Improvement For Some Cultivars of Wheat Pllants Grown on Hydroponic Media

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ABSTRACT

Using hydroponic technique, the effects of silicon application (0 and 2 mM Si) on the salt tolerance of some wheat genotypes grown under various levels of salt stress (0, 50 and 150 mM NaCl)) were investigated for three cultivars of wheat (Sakha 93, Gemmaiza 9 and Giza 168). Silicon application improved the dry weight of shoots and roots of Sakha 93 and Gemmaiza 9 under all levels of salinity.The roots of Giza 168, at 0 and 50 mM NaCl, slightly decreased the shoot dry weight of Giza 168. In plant shoots of all tested seedlings, sodium concentration increased and potassium slightly decreased with increasing salinity and more Na increments and K decrements were observed with Si application except at 150 mM NaCl where Si application to Sakha 93 reduced Na in shoot by 22.7% than in those of non Si- treated shoots. In plant roots, Na concentration highly decreased while K concentration increased in seedlings of Sakha 93 with NaCl salinity increase and vice versa in Gemmaiza 9 and Giza 168 seedlings. Silicon application to Sakha 93 caused more significant reductions in Na concentration by root with higher levels of NaCl salinity. In comparison with other cultivars, Sakha 93 showed a defense mechanism(s) by decreasing Na^+, increasing K^+ and increasing K^+/Na^+ ratio in root system and application of Si improved these mechanisms. At high levels of salt stress (150 mM NaCl), presence of Si decreased Na^+ uptake by shoots of Sakha 93 which reflects defense mechanism against N^+ translocation to shoot under high salt stress. In general, the statistical analysis of results of growth parameters and Na^+ and K^+ concentrations in wheat plants showed that wheat genotypes had major role in salt tolerance and Si application improved Sakha 93 and Gemmaiza 9 to maintain high shoot and root dry weights under salt stress and enhanced the defense mechanisms of Sakha 93 for salt tolerance. The results confirmed that Sakha 93 genotypes is considered a salt tolerant and both Gemmaiza 9 and Giza 168 could be salt sensitive cultivars.

Key Words: salt tolerance,wheat genotyes, silicon, hydroponic

INTRODUCTION

Salinity is considered a major factor in limiting plant growth and crop productivity, The salinisation of irrigated and surrounding areas in the arid soils has not been diminished. On the contrary, it continues to increase in arid and semi-arid regions (Rus *et al.*, 2000). It is estimated that about a third of the world's cultivated land is affected by salinity (Perez-Alfocea *et al.*, 1996). Salinity poses several problems especially for glycophytes, by inducing physiological dysfunction (Shannon *et al.*, 1994). The relationships between salinity and mineral nutrition of horticultural crops are extremely complex and a complete understanding of the indicate interactions involved would require the input from a multidisciplinary team of scientists (Grattan and Grieve, 1999). Salinity can be minimized with reclamation but the cost of engineering and management is very high. Increasing costs of water and energy emphasizes the need for an alternative strategy (Shannon, 1984). An alternative strategy for overcoming the negative effects of salinity on the plant growth and yield could be to attempt to supplement silicon where irrigation water is known to be or may become saline.

Silicon is the second most abundant mineral element in the soil after oxygen and comprises 31% of the earth's crust which occurs in the soil solution at 0.1–0.6 mol m^{-3} as $Si(OH)_4$ (Epstein 1999). However, the role of silicon in plant biology is still poorly understood (Epstein 1999; Liang et al. 2003; Zhu *et al.* 2004). Although silicon has not yet been considered a generally essential element for higher plants, numerous studies have demonstrated that silicon is one of the important elements for plants, and plays an important role in tolerance of plants to environmental stresses [Epstein, 1999 and Savant *et al.*, 1999]. Relatively more attention has been paid to the roles of silicon in controlling disease [Raid *et al.*, 1992 and Rodrigues *et al.*, 2003] and pest [Pan et al., 1979 and Elawad *et al.*, 1985], alleviation the toxicity of heavy metals [Neumann and Nieden, 2001 and Hodson, A.G. Sangster, 2002] and salt stress (Liang *et al.*, 1996; Liang, et al., 2003; and Zhu *et al.*, 2004).

The role of silicon in the alleviation of salinity stress in plants has been observed *in wheat (Ahmad et al., 1992), barley (Liang et al.*, 2003, 2005), tomato (Alaghabary *et al.*, 2004), rice (Matoh *et al.*, 1986; Yeo *et al.*, 1999), cucumber (Zhu *et al.*, 2004) and maize (Shu and Liu 2001). However, the mechanism (s) for these effects of silicon is still unclear. Matoh *et al.* (1986) suggested that silica deposition in the leaf decreased transpiration and therefore decreased salt accumulation. Ahmad *et al.* (1992) suggested that silicon complexed sodium in