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Saline stress tolerance in legumes

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The economic importance of legumes is related with their capacity to fix atmospheric nitrogen, thereby reducing agricultural cost through a reduction of fertilizer inputs and decreasing environmental contamination. The process of biological nitrogen fixation is present in many ecosystems and it is efficiency is determined by the environmental conditions. Saline stress is one of the main factors limiting legume productivity in arid and semi-arid regions affected by water or soil salinity, particularly when plant growth depends on symbiotic nitrogen fixation, since high salt concentrations in soil is also a negative factor for growth and activity of soil bacteria that establish symbiosis with legumes, collectively called rizobia (Asraf and Harris, 2004). The area of land affected by secondary salinity (salinity caused by human activity) is steadily increasing, with recent worldwide estimates that over 70 million ha of agricultural land is affected (FAO, 2005). Salinity impact on plants in two main ways: osmotic stress and ion toxicity (Munns, 2005). Osmotic stress is caused by ions (mainly Na^+ and Cl^-) in the soil solution decreasing the availability of water to roots. Ion toxicity occur when plant roots take up Na^+ and/or Cl^- and these ions accumulated to detrimental levels in leaves. Ion imbalances and nutrient deficiency, particularly for K^+ nutrition, can be also occur (Tejera *et al.*, 2006). The accumulation of compatible solutes in considered an adaptative response and therefore, molecular indicators of tolerance to salt stress and solutes should be studied within the highly specialized structures of legumes, the root nodules. The capacity of nodules to maintain a significant level of nitrogen fixation under salt conditions is determined by the energetic processes (nodule and bacteroid responses) and metabolic processes that lead to the export and import of photosynthesized and by the senescent processes. At the cellular level, the information on nodule and bacteroid metabolites, the enzymes involved in carbohydrate metabolism and enzymes required for assimilation of fixed nitrogen are essential to understand the consequences of saline stress on nodule functioning and therefore on the symbiosis. Salinity induces changes in the plant hormonal balance not only by the accumulation of ABA but also inducing a reduction of the levels of growth-activating hormones such as auxins and cytokinins. Ethylene and other growth regulators like salicylic acid play an important role in the response to salt stress (Glyan´ko *et al.*, 2005) due to its ability to induce a protective effect on plant under stress. In addition, it has been reported the efficiency of pre-treatments with different phytohormones for restoration of metabolic alterations induced in some legumes by NaCl, such as *Vicia faba*, *Vigna* and *Phaseolus vulgaris* (Khadri *et al.*, 2006). Recent research on high salinity responses in *Medicago truncatula* and *Lotus japonicus* implied that a large proportion of the genome is involved in high-salinity stress responses (Udvardi *et al.*, 2007). Genome-wide identification of genes regulated by drought of high salinity conditions has manifold significance.

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