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IMPROVING SALINITY TOLERANCE IN CROPS: A BIOTECHNOLOGICAL VIEW

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ABSTRACT

Abiotic stress is a major global problem limiting crop productivity of the modern cultivars. Abiotic stresses like salinity and heavy metal are the primary causes of crop failures in India. Salinity in soil or water is one of the major abiotic stresses that decrease plant growth and crop yield globally. Crops are nutritionally very rich and even superior. Due its nutritional superiority and requirement by people, production needs to be improved. Overcoming salinity stress *in vitro* and evaluating performance of field grown plants under similar conditions in future and thus proposing solutions to the farmers. Field selection for salinity tolerance is a laborious task; so plant breeders are in search of reliable ways to evaluate the salt tolerance of plant germplasm. Salt tolerance in several plant species can work at the cellular level, and glycophytes are assumed to have special cellular mechanisms for salt tolerance. Ion exclusion, ion sequestration, osmotic adjustment, macromolecule protection, and membrane transport system adaptation to saline environments are significant strategies that may possibly confer salt tolerance to plants. Successful application of biotechnology to the salinity constraints facing crop plants will require both a good biological knowledge of the target species and the mechanisms underlying tolerance to this stress. However, plant biotechnology should be integrated with the classical breeding programs to achieve maximum efficiency.

Keywords: Crops, Abiotic Stress, Salinity, Germplasm, Breeding.

INTRODUCTION

Salinity and Heavy metals limits the production capabilities of farming soils in huge areas of the world. Equally breeding and screening germplasm for salt tolerance come across the following limitations: (1) Various phenotypic responses of plant life at different growth stages, (2) Various physiological mechanisms, (3) complicated genotype environment interactions, and (4) variability of the salt and heavy metal affected field area in its chemical and physical soil composition. Plant molecular and physiological traits make available the bases for efficient germplasm screening trial through traditional breeding, molecular breeding, and transgenic approaches. However, the quantitative character of salinity stress tolerance and the troubles associated with rising appropriate and replicable testing environments create it complicated to differentiate salt-tolerant lines from sensitive lines. In order to build up additional efficient screening trial for germplasm evaluation and improvement of salt tolerance, implementation of a rapid and reliable screening method is necessary. Field selection for salinity tolerance is a laborious task; so plant breeders are in search of reliable ways to evaluate the salt tolerance of plant germplasm.

Salt tolerance in several plant species can work at the cellular level, and glycophytes are assumed to have special cellular mechanisms for salt tolerance. Ion exclusion, ion sequestration, osmotic adjustment, macromolecule protection, and membrane transport system adaptation to saline environments are significant strategies that may possibly confer salt tolerance to plants. Cell and tissue culture techniques have been used to get salt tolerant plants employing two in vitro culture approaches. The first is selection of mutant cell lines from cultured cells and plant regeneration from such cells (somaclones) and second approach is In vitro screening of plant germplasm for salt tolerance. Doubled haploid lines resulting from pollen culture of F1 hybrids of salt-tolerant parents shows potential tools to further advance salt tolerance of plant cultivars. Development of resistance against both hyper-osmotic stress

and ion toxicity can also be achieved via molecular breeding of salt-tolerant plants using also molecular markers or genetic engineering. Salinity in soil or water is one of the major abiotic stresses that decrease plant growth and crop yield globally. Over 800 million hectares of land all over the world are salt-affected (including both saline and sodic soils), equating to more than 6% of the world's total land area (FAO 2008).
Some of the most serious examples of salinity occur in the arid and semiarid regions. For example in India Iran, Pakistan, Egypt, and Argentina, land area of million hectares, are salt-affected (FAO 2008). Low rainfall, high evaporation, native rocks, saline irrigation water, and poor water management increasingly cause salinity problems in agricultural land. It is estimated that 230 million hectares of land under irrigation, 45 million hectares are salt-affected (20%) and of the 1500 million hectares of dryland agriculture, 32 million hectares are salt-affected (2%; FAO 2008). Overall, it was estimated that the world is losing at least 3 ha of arable land every minute because of soil salinity (FAO 2008).

FUTURE DIRECTION OF RESEARCH

Salinity and drought still stay the major abiotic stresses that bound and pose a threat to agricultural production in many areas of the whole world (Altman 2003). Though a number of mechanisms involving to improved stress adaptation in crops have been suggested, the truth leftovers that their involvement with genetic gains for yield and their relative significance in various salinity-prone environments are still only partially defined. For that reason, a well-focused advance combining the molecular, physiological, and metabolic aspects of abiotic stress tolerance is essential for bridging the knowledge gaps between short- and long-term effects of the genes and their products, between the molecular or cellular expression of the genes and the whole plant phenotype under stress (Bhatnagar-Mathur *et al.* 2008). Marker-assisted selection can be effectual in increasing efficiency but, at least up to now, selection for markers connected to constituent traits of low heritability has not formed predicted outcomes.
Current improvement of molecular marker technologies will make marker-assisted selection for major QTLs or the applicant genes less expensive and more effective in the future. Transgenic technology will unquestionably continue to support the search for the cellular mechanisms that underlie tolerance, but the difficulty of the trait is expected to signify that the path to engineering such tolerance into sensitive species will be time-consuming (Flowers 2004). Successful application of biotechnology to the salinity constraints facing crop plants will require both a good biological knowledge of the target species and the mechanisms underlying tolerance to this stress. However, plant biotechnology should be integrated with the classical breeding programs to achieve maximum efficiency (Altman 2003).
Salinity manages through recovery of salinized land or enhanced irrigation techniques are often prohibitively luxurious and provide only a temporary solution (Ashraf 1994; Shannon 1997; Singh and Singh 2000). Around half of the world's Area surface is "perennial desert or dry lands" and can only be through more fruitful by irrigation. Unfortunately, a strong connection with salinization (Ghassemi et al. 1995) throws an urgent query over the sustainability of using irrigation to enhance food production, such that the main value of increasing the salt tolerance of crops will be to ensure sustainability of the profit brought by irrigation (Shannon and Noble 1990;

Flowers and Yeo 1995; Rengasamy 2006). If worldwide food production is to be maintained, it seems reasonable to expect that enhancement of the salt tolerance of crops will be an increasingly significant aspect within a widening amount of plant breeding programs. The goals of plant breeding in this attempt are to develop cultivars that can grow and produce economic production under sort of saline environment (Epstein et al.1980; Flowers and Yeo 1995; Shannon 1997). Plant variety and cultivars within a crop species differ very much in their response to salinity (Marschner 1995). Genetic diversity within a crop species, thus, provides a practical means for screening and breeding for better salt tolerant cultivars. Some screening and selection schemes have been planned for salt tolerance improvement in wheat and other crop species (Kingsbury and Epstein 1984; Kelman and Qualset 1991; Karadimova and Djambova 1993; Pecetti and Gorham 1997). Field screening trial in saline soils are confronted by spatial heterogeneity of soil chemical and physical properties as well as seasonal variation in rainfall (Munns and James 2003). Therefore, many screening experiments for salt tolerant genotypes were conducted also under in vitro or under restricted environmental conditions (Kingsbury and Epstein 1984).

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