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Biotechnology and Abiotic Stress Tolerance in Rice

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World population is escalating day by day and by 2050 it is expected to reach 9.1 billion, but agricultural production is not rising at a parallel pace. In order to feed the world population, global agricultural production should be increased by 60-110 per cent and 70 per cent more food for an additional 2.3 billion people by 2050 [1,2]. Agriculture production is dwindled mainly due to biotic and abiotic stresses. Abiotic stress is one of the major factors which negatively affect the crop growth and productivity world-wide. Hence, these are one of major area of concern to fulfill the required food demand [3,4]. The major abiotic stresses worldwide causing risks to food security are high salinity, drought, submergence and cold [5,6]. Among these stresses, drought is the first environmental stress responsible for decrease in agricultural production worldwide and to fulfill the demand, tons of efforts are being applied to improve crop yields [7,8]. Drought affects plants in countless ways like it affects plant growth, yield, membrane integrity, pigment content, osmotic adjustments, water relations and photosynthetic activity [9]. Salinity is the second most prevalent soil problem in rice-growing countries after drought [10] and rice is considered as a salt sensitive crop in early seedling stages [11] which limits its productivity [12,13]. Among 130 mha of world rice area, approximately 30 per cent area contains salt levels too high to allow normal rice yield. The decline in rice yield under reasonably salt-affected soils is anticipated to be 68 per cent [14]. Due to global warming, rise in sea levels, surplus irrigation without appropriate drainage in inlands and underlying rocks rich in detrimental salts, area under salt stress is growing. It is expected that if present scenario persists, 50 per cent of current cultivated land will be loss for agriculture by 2050 [15]. Cereals are the most significant source of calories to humans. Rice, wheat and maize offer 23%, 17% and 10% calories globally [16]. Rice (*Oryza sativa*L.) is a well-known cost-effective cereal, also staple food included in the diet. It is a chief and most vital source of food for more than half of the population and more than 90 per cent of the world's rice is grown and consumed in Asia, where 60 per cent of the earth's people live and also a major income means to rural people [17]. Embracing of green revolution varieties lead to a radical transformation in rice production. Between 1996 and 2011, the population of thickly populated low-income countries raised by 110 per cent, but rice production increased by 180 per cent from 257 million tons in 1996 to 718 million tons in 2011. Even with these advances in rice production, still 800 million people are not getting food every day. It is anticipated that we will have to produce 25 per cent more rice by the year 2030 [18]. This supplementary rice has to be produced from fertile lands without bringing up additional weak lands for rice cultivation. To improve the yield under drought and salt stress condition, countless breeding programs have been initiated. Although conventional breeding programmes such as hybridization, hybrid breeding, wide hybridization and ideotype breeding have resulted in development of some salt-and drought tolerant rice varieties and several lines have been released in the Philippines, Bangladesh and India [19], but the success rate of conventional breeding is not ample [19]. Drought tolerance in rice is a complex trait and it is determined by various component traits. These traits are governed by many genes with huge environmental interaction, with low heritability, and thus are difficult to investigate [20]. Salinity stress tolerance is a quantitative trait which is controlled by multiple genes [21]. So there is a need to develop rice varieties that can withstand high levels of drought and salt and at the same time uphold optimal yield levels. The development of plant transformation techniques during the past decades has made it possible to develop improved crop plants by introduction of cloned genes. The two critical steps accountable for transformation of plants are transfer of foreign DNA into the plant cell and regeneration of plants from transformed cells. The callus induction and regeneration in tissue culture of rice depends upon different factors like genotype, type of explants and media supplement like basal salts, organic component and growth regulator. Among them most crucial factor is genotype [22]. Development of genetically engineered plants with enhanced tolerance to drought and salinity is an important challenge in rice biotechnology research. Rice transformation is a major goal in cereal biotechnology, because rice is world's most important food crop and it is also known as model of cereal genomics. Genetic engineering has been used as a prominent tool for rice improvement. Although gene transformation in japonica rice is performed routinely in several laboratories, the system in *indica* rice is comparatively complicated. However, since the number of copies of a gene(s) inserted and chromosomal locations of the integrated genes are not controllable, the expression of the introduced genes varies among individual transformants. Therefore, relatively large number of transgenic plants must be developed in order to select desirable transformants as well as to study the expression of introduced genes. Since the last two decades, a large number of salinity tolerance genes were isolated and cloned which are involved in signal transduction, transcription regulation, ion transporters and metabolic pathways. Lots of work has been done by introducing these genes into rice. Still, there is ample scope for this research because till now none of the rice variety is released so far which has magical tolerance to abiotic stress. In conclusion, to feed the ever growing population, we need to solve the abiotic stress problem in rice and this is the principal challenge for plant biotechnologist. Despite the discovery of lots of genes, still it is a bigger challenge to meet the demand.

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