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Towards Development of Superior Brassica juncea by Pyramiding of Genes of Diverse Pathways for Value Addition, Stress Alleviation and Human Health

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Abstract : Global issues are leading to concerns over food security. These include climate change, urbanization, increase in population subsequently leading to greater energy and water demand. Futuristic approach for crop improvement involves gene pyramiding for agronomic traits that empower the plants to withstand multiple stresses. In an earlier study from the laboratory, the efficacy of overexpressing γ-tocopherol methyl transferase (γ-TMT) gene from the vitamin E biosynthetic pathway has been shown to result in six-fold increase of the most biologically active form, the α-tocopherol in Brassica juncea which resulted in alleviation of salt, heavy metal and osmoticum induced stress by the transgenic plants. The glyoxalase I (gly I) gene from the glyoxalase pathway has also been earlier shown by us to impart tolerance against multiple abioitc stresses by detoxification of the cytotoxic compound methylglyoxal in Brassica juncea. Recently, both the transgenes were pyramided in Brassica juncea lines through sexual crosses involving two stable Brassica juncea lines overexpressing γ-TMT and gly I genes respectively. The transgene integration was confirmed by PCR analysis and their mRNA expression was evident by RT-PCR analysis. Preliminary physiological investigations showed ~55% increased seed germination under 200 mM NaCl stress in the pyramided line and 81% higher seed germination under 200 mM mannitol stress as compared to the WT control plants. The pyramided lines also retained more chlorophyll content when the leaf discs were floated on NaCl (200, 400 and 600 mM) or mannitol (200, 400 and 600 mM) compared to the WT control plants. These plants had higher Relative Water Content and greater solute accumulation under stress compared to the parental plants having γ-TMT or the glyI gene respectively. The studies revealed the synergy of two components from different metabolic pathways in enhancing stress hardiness of the transgenic B. juncea plants. It was concluded that pyramiding of genes (γ-TMT and glyI) from diverse pathways can lead to enhanced tolerance to salt and mannitol stress (simulating drought conditions). This strategy can prove useful in enhancing the crop yields under various abiotic stresses.

Keywords : abiotic stress, brassica juncea, glyoxalase I, α-tocopherol
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