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Evaluation of Cd^{2+} Stress Tolerance in Transgenic Rice by Overexpressing PgGPx Gene that Maintains Cellular Ion and Reactive Oxygen Species Homeostasis

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Abstract

Increasing contamination and higher enrichment ratio of non-essential heavy metals induce various toxic responses in plants when accumulated above the threshold level. These effects and growth responses are genotype and heavy metal level dependent. Cadmium, a non-essential toxic heavy metal, interferes with the plant growth and development. It reaches the leave through xylem and may become part of the food chain, thus causing detrimental effect to human health. Therefore, there is an urgent need to develop strategies for engineering plants for Cd^{2+} tolerance and less accumulation. Plant species generate a range of defense mechanisms to resist Cd^{2+} induced toxicity and to recover the subsequent damages eliciting their genotype based biochemical responses. To counter damages plants have an efficient system of stress enzymes and antioxidant non-enzyme molecules that is termed as antioxidant system. The members of peroxidase family of antioxidant system, transport metal ions including Cd^{2+}, and thus play important role an ion homeostasis. The present study elucidates the role of a Pennisetum glutathione peroxidase (PgGPx) in Cd^{2+} stress tolerance. Transgenic rice expressing PgGPx showed tolerance towards Cd^{2+} stress as demonstrated by several physiological indices including root length, biomass, chlorophyll, malondialdehyde and hydrogen peroxide content. Roots of the transgenic lines accumulated more Cd2+ as compared to shoot. PgGPx expression in rice also protected the transgenic plants from oxidative stress by enhancing the activity of antioxidant enzymatic (SOD, CAT, APX, GR) machinery. Thus, overexpression of PgGPx confers Cd^{2+} stress tolerance in transgenic lines by maintaining cellular ion homeostasis and modulating reactive oxygen species (ROS)-scavenging pathway. Thus, the present study will help to develop strategies for engineering Cd^{2+} stress tolerance in economically important crop plants.

Keywords: Cd^{2+} stress, PgGPx, rice, ROS

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