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A TOMATO GST GENE ENHANCES TOBACCO TOLERANCE UNDER DIFFERENT ABIOTIC STRESSES

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Climate change is dramatically affecting cultivable areas and diminishing natural resources, posing significant challenges to food security worldwide. Abiotic stresses are estimated to reduce approximately 70% of crop productivity. Reactive oxygen species (ROS) play a key role in plant response to stress as signal transduction molecules. However, exceeding ROS promotes damage to cellular components inducing metabolic dysfunction and cell death.

To limit oxidative damage under stress condition plants have developed finely regulated antioxidant pathways for detoxification of excessive ROS. Among other antioxidant enzymes, glutathione S-transferase (GSTs) are induced by various environmental stimuli and are involved in the oxidative stress protection. However, knowledge about processes involving gst genes in controlling plant tolerance to stress remains elusive. Previous evidence suggested that the expression of a gene encoding a tau GST in S. lycopersicum associated with accumulation of antioxidant molecules. The goal of our research was to gain the proof-of-concept on the role of the target gene in controlling the biosynthesis of antioxidants and the redox state of plant tissues and assess its impact on the plant tolerance to environmental stresses.

Nicotiana tabacum plants over-expressing the Solyc07g056420 gst coding sequence responded to salt stress with larger increase in root biomass and

reduced plant height, lower reduction in leaf relative water content, increase in antioxidant capacity in the lipophilic fraction and reduction in the protein fraction. Conversely, drought-stressed plants showed a reduced drop in leaf photo-assimilation and stomatal conductance, a higher reduction in anthocyanin levels and increases in leaf flavonoids and Chlorophyll A and B levels.

To investigate the role of the tomato gst gene in controlling the redox homeostasis by modulating the Foyer-Halliwell-Asada cycle transgenic plants challenged with salt and drought treatments underwent an analysis of gene expression. The over-expression of the gst gene in transgenic Nicotiana tabacum plants induced the downregulation of genes involved in ascorbate and glutathione metabolism under salt stress suggesting a shortage of reduced glutathione that could lead to increased levels of ROS and early stomata closure. On the other hand, transgenic plants responding to drought highlighted the upregulation of genes encoding for glutathione reductase possibly involved in the effort to compensate GSH shortage with an increase in the biosynthetic flux.

Our results suggested that tomato gst gene Solyc07g056420 regulate the plant response to abiotic stresses by tuning gene controlling the redox homeostasis. However, the extend of the effect on the plant tolerance depend on the specific stress. A deeper understanding of regulative mechanisms involving gst genes will pave the way for developing crops with enhanced tolerance to environmental challenges.