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Short Communication

Control of Photosynthetic Transcription in Response to Heat Stress

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DESCRIPTION

The earth's temperature has risen as a result of global warming creating a significant abiotic stress that poses a serious threat to plants. One of the plant cell processes that is particularly vulnerable to the stress of high temperatures is photosynthesis, which is frequently inhibited before other cell processes are hampered. Photosystem II (PSII), ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco), as well as cytochrome b559 (Cytb559) and Plastoquinone (PQ), are the main targets of high temperature stress. PSI is more stable at higher temperatures than PSII. High temperature stress has repercussions including the creation of ROS, heat shock proteins, and secondary metabolites [1].

In higher plants, chloroplasts use photosynthesis to capture sunlight and transform it into biological energy. In addition to acting as metabolic hubs, these organelles are crucial for detecting heat stress and triggering the proper physiological adaptation responses. Heat stress affects a number of processes that are involved in photosynthesis, including electron transport, CO_2 assimilation, photo-phosphorylation, Chlorophyll (Chl) production, thylakoid membrane fluidity, and photochemical reactions [2]. These key metabolic functions often maximize carbon fixation and growth. Heat stress-induced damage to chloroplasts leads to the inactivation of heat-sensitive proteins such as Rubisco Activase (RCA) and the down-regulation of important chloroplast components, thereby leading to decreased photosynthetic efficiency, redox imbalance and possible cell death. As the photosynthetic apparatus within chloroplasts is prone to damage due to thermal stress, these organelles are key to the activation of cellular heat stress signaling processes [3].

Protein biosynthesis drives the formation and development of every living organ as a vital biological activity. Heat shock Proteins (HSPs) have developed in plants to react to heat stress. During the processes of protein quality control, these proteins function as molecular chaperones to encourage the folding and refolding of non-native proteins. The Heat Shock Cis Element (HSE), which is conserved in the HSP gene promoter, is recognized by the Heat Shock Transcription Factor (HSF), which controls the production of HSP genes. Numerous investigations have been conducted to look into the roles of HSFs and HSPs. Even while these have significantly improved our understanding of the heat stress response in plants, the regulatory network that governs the heat shock response system still needs much more research. Transcript factors responding to heat stress may play a crucial role in the tolerance to abiotic stress since adaptive response functions, at least in part, through the control of gene expression [4].

The response to heat stress is influenced by numerous gene-environment interactions that can occur. Microarray and extensive transcriptome investigations have helped to pinpoint a wide variety of abiotic stress response genes in plants. By creating essential metabolic proteins and enzymes and controlling gene expression and signal transduction in the event of stress, these genes help protect cells from harm. Transcriptional Factors (TFs), which are regulating proteins, play important roles in converting the perception of stress signals into the expression of stress responding genes. This is accomplished through the interaction with cis-acting elements present in various distinct stress responding gene promoter regions during signal transduction. As a result, it can start a signaling cascade that helps plants be more resilient to adverse environmental conditions. In comparison to yeasts and animals, TFs account for about 7% of the coding sequences in the plant genome, and most of them are found in big gene families, such as the Heat Stress Transcriptional Factors (HSFs) family. The number and expression of genes involved in controlling photosynthesis in trees under heat stress are still unclear. Characterizing and identifying the genes involved in plant heat stress resistance is therefore crucial [5].

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