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Membrane thermostability and gene expression of small heat-shock protein (sHSP) in weat shoots exposed to elevated temperatures and water deficiency

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Abstract

The temperature dependence of the permeability of cell membranes was studied in the range of 49-57°C by the conductometric method recording of electrolyte exosmosis from intact plant leave tissues of 7-day seedlings of three spring wheat (Triticum aestivum L.) varieties grown under different conditions of heat shock (Hs) and drought. The samples were heated at a given temperature for 5 min and the following kinetic parameters of thermostability membranes were determined: threshold membrane damage temperature (TMDT), slope of the temperature curves, and membrane damage coefficients (MDK) characterizing the amplitude and speed of thermotropic transitions. We found variety-specific differences in these parameters that allowed us to range the wheat genotypes studied according to the heat-resistance. Gene expression of sHspl6.9B and sHspl7.3 was evaluated by the content of the mRNA transcripts using the methods of relative RT-PCR and northern blot hybridization. In control samples a weak constitutive gene expression was detected; however, under the stress conditions - combined action of Hs and preceding thermoadaptation or drought - an increase of gene expression was found, especially for gene sHspl7.3, suggesting that the activity of these genes is stress-regulated. More ponounced differences between varieties with contrasting thermostability were found by the northern blot analysis of the sHspl7.3 gene transcripts. Under stress conditions, higher amount of transcripts of this gene was observed in highly resistant plant varieties with enhanced thermal stability of membranes as compared with less resistant plants. These results suggest a variety-specific dependence of the gene sHspl7.3 activity and a direct correlation of its transcription with the thermal stability of membranes and resistance of plants to hypothermia. We assume that the induction of synthesis and accumulation of sHspl7.3 ensures a higher membrane thermostability due to better association of the membranes with a pool of this protein, which prevents fluidization and disintegration of the lipid bilayer during high-temperature stress and water deficit.

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Keywords

Gene expression, Hyperthermia, Membranes, Small heat shock protein, Thermostability, Triticum aestivum, Water deficit