Biochemistry (Moscow) 2003 vol.68 N6, pages 678-687

Effects of abscisic acid, low temperature, and plant age on cytoskeleton and phosphorylated proteins

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Abstract

The effects of exogenous abscisic acid (ABA), low temperature, and seedling age on the content of tubulin, actin, and phosphorylated proteins and the structural organization of microtubules (MTs) in cells of different tissues and organs of winter wheat cultivars contrasting in cold hardiness were studied by immunocytochemical methods using monoclonal (against α- and β-tubulin and actin) and polyclonal (phosphothreonine) antibodies. The leaves and roots of five- and nine-day-old seedlings of three cultivars were characterized by unequal proportion of actin/tubulin proteins. ABA decreased the content of the cytoskeleton and the 60-kD phosphorylated proteins, thus promoting a decrease in the number of MTs and occurrence of a less branched network of weakly fluorescent tubulin components in the cells of the root differentiating zone (which is most responsible for the development of cold hardiness in wheat). Although the cold acclimation of plants (3°C, 7 days) did not change the level of tubulin and actin proteins, it evoked the spatial aggregation of MT, leading to formation of a dense network of tubulin cytoskeleton comprised of thick bundles of intensively fluorescent MTs. In the case of a combined action of the studied factors, low temperatures abolished the hormone effect described above, evoking an increase in the content of the cytoskeletal and 60-kD phosphorylated proteins and MT structures. We suggest that the ABA-induced decrease in the levels of proteins and MTs occurs at the initial stages of plant cold acclimation (3°C, 2-3 days). It may be the signal that triggers the processes of low-temperature adaptation. As the duration of cold acclimation increased (3°C, 7 days), the role of ABA in the formation of plant tolerance decreased. Apparently, in this case other hormone-independent mechanisms of frost hardiness development are triggered, in which the role of the cytoskeleton components and cytoskeleton-associated proteins increases.

http://dx.doi.org/10.1023/A:1024674011448

Keywords

ABA, Actin, Cold acclimation, Cytoskeleton, Microfilaments, Microtubules, Phosphorylated proteins, Triticum aestivum L., Tubulin