Russian Journal of Plant Physiology 2004 vol.51 N5, pages 684-696

Oryzalin-induced changes in water status and cytoskeleton proteins of winter wheat seedlings upon cold acclimation and ABA treatment

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Abstract

The effect of oryzalin (a specific inhibitor of tubulin polymerization in plant cells) on water retention by the leaves and roots of winter wheat (Triticum aestivum L.) seedlings was studied. The cultivars differing in their frost resistance were compared after their acclimation to low temperature (3°C for 3 or 7 days) and after treatment with ABA. In control untreated plants, oryzalin reduced the water-retaining capacity (WRC) of leaves and roots. Both hardening and ABA lowered the effect of the inhibitor on WRC in leaves, whereas their effects on water retention by roots were opposite, i.e., hardening weakened and ABA intensified the effect of oryzalin. Oryzalin-induced reduction of WRC decreased in the following sequence of cultivars: weakly frost resistant → moderately frost resistant → highly frost resistant. It was more pronounced in the leaves than in the roots, the latter being characterized by the lower WRC and lower frost resistance. After three-day-long hardening of plants, an additive effect of hypothermia and ABA on oryzalin-induced decrease in WRC of leaves and the lack of such effect in the roots were observed. The immunochemical analysis of the composition and content of cytoskeletal proteins with Western blotting showed that in the leaves the actin/tubulin ratio was higher than in the roots. The treatment of nonacclimated plants with ABA lowered the content of α- and β-tubulins and actin in roots but did not affect the level of actin in leaves. Hardening negated the effects of ABA on cytoskeletal proteins. Oryzalin produced the greatest inhibitory effect on WRC and an increase in frost resistance in ABA-treated plants in the experiments with leaves of the weakly frost resistant cultivar before and after hardening. Organ- and cultivar-specific and ABA-mediated dependence of WRC on cytoskeletal proteins and microtubules and microfilaments formed by them is supposed to result from their effect on the state of intracellular water and water permeability of the plasma membrane. In the course of cold acclimation of plants and upon their treatment with ABA, this dependence was more distinctly expressed in leaves than in roots, and especially in the plants of the weakly frost resistant cultivar.

http://dx.doi.org/10.1023/B:RUPP.0000040757.07698.d8

Keywords

ABA, cold acclimation, cytoskeleton, frost resistance, leaves, roots, Triticum aestivum, various cultivars, water status