PHOTOSYNTHETIC ACCLIMATION TO COLD HARDENING IN BARLEY GENOTYPES CONTRASTING FOR FROST TOLERANCE

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An important effect of the acclimation to low temperature is an increased tolerance to photoinhibition of photosynthesis. Photoinhibition can occur if the rate of light harvesting by PSII exceeds the capacity of electron transport, which is reduced by low temperature. Together, temperature and light intensity affect the relative reduction state of the PSII, which appears to be the primary target of photoinhibition. In wheat and rye, sensing of PSII excitation pressure has been proposed to cause in winter and spring genotypes differential adjustment in photosynthetic capacity, gene induction and plant morphology. (Oquist et al, 93; Gray et al., 1997; Ndong et al, 2001). The genetic variability for these responses, however, has been little investigated in cereals.

Objective of the present work was to analyse a) whether similar mechanisms operate in barley, a species with lower frost tolerance with respect to rye and wheat, b) if genotypes contrasting for frost tolerance show differential photosynthetic acclimation.

Plants were grown under varying PSII excitation pressure by simulating at early stage of growth different conditions of pre-hardening (12°C/7°C) hardening (3°day/1°C night), and non hardening (20/15°C). Two growth light intensity (200 or 700 mE m⁻² s⁻¹) were employed for pre-hardened and non-hardened plants. The kinetics of acclimation was measured using chlorophyll fluorescence and photosynthetic gas-exchange analysis in relation to plant growth and frost hardness.

Results confirmed in plants acclimated to higher PSII excitation pressure an improved capacity to maintain oxidized the PSII, associated to a higher tolerance to photoinhibition. The pre-hardening treatment was effective in improving the frost tolerance of all genotypes and in distinguishing tolerant and susceptible genotypes. Plants grown at 700 mE acquired a higher level of frost tolerance with respect to those grown at 200mE. The genotypes here analysed showed at 20/15°C a quantum yield of PSII (Fₚₛₛᵢ) constitutively different, independently on their frost tolerance; however the photochemical efficiency after acclimation was enhanced at greater extent in the tolerant genotypes. Work is in progress to assess if the increased proportion of open PSII reaction centres during acclimation to high PSII excitation pressure is a result of an increased capacity for CO₂ assimilation.

Ndong C, Danyluk J, Huner NPA, Sarhan F. Plant Molecular Biology 45: 691-703, 2001