Proceedings of the 7th Hungarian Congress on Plant Physiology, 2002
S2-P05

Volume 46(3-4):85-86, 2002
Acta Biologica Szegediensis
http://www.sci.u-szeged.hu/ABS

Changes in water and chlorophyll fluorescence parameters under osmotic stress in wheat cultivars

Ágnes Gallé*, Jolán Csiszár, Irma Tari, László Erdei

Department of Plant Physiology, University of Szeged, Szeged, Hungary

ABSTRACT Drought tolerant wheat cultivars exposed to low water potential can be characterized by growth response, stomatal conductance of leaves, by changes in water relations and ion accumulation of tissues and by fluorescence induction parameters under water stress. Two strategies of acclimation to drought stress have been found: plants using the first strategy save tissue water content by a fast decrease of stomatal conductance, maintain pressure potential and photosynthetic activity of leaves. In the second group the closure of stomata occurs later resulting in an intensive loss of water and a fast decrease of water potential in the leaves and tissues restore their turgor after a relatively long acclimation phase.
Acta Biol Szeged 46(3-4):85-86 (2002)

KEY WORDS

drought stress
stomatal conductance
fluorescence induction parameters
water relations of tissues
wheat cultivars

Drought stress is one of the most important abiotic stress factors which are generally accompanied by heat stress in dry season (Dash and Mohanty 2001). Breeding programmes of bread wheat seeking increased yield have usually attempted to improve drought tolerance of plants. Before successful genetic manipulation it is important to characterize the physiological parameters of known drought tolerant or sensitive cultivars (Bray 1997). Drought tolerant wheat species can be characterized by growth response, changes in water relations of tissues exposed to low water potential, stomatal conductance, ion accumulation and changes in fluorescence induction parameters under water stress (Blum 1988).

Materials and Methods

Wheat seedlings (*Triticum aestivum* L. cultivar Öthalom and a landrace Kobomugi) were grown in complete nutrient solution. The osmotic potential of the culture solution was adjusted with PEG 6,000 in two steps to 200 mOsm on the 7th day and to 400 mOsm on the 9th day. All experiments were performed with the second leaf of seedlings. The fluorescence measurements were made with PAM-2000 fluorometer on 3 parallel samples at 180 or 2200 µmol $m^{-2}s^{-1}$ light intensities. Quantum efficiency of PSII in dark adapted (Fv/Fm) or illuminated leaves (F_m'-F_s/F_m'), the rate of photosynthetic electron transport (ETR), non photochemical quenching (qN) and photochemical quenching (qP) parameters were determined. The osmotic potential of the expressed tissue fluid was measured by digital automatic osmometer. A pressure chamber was used for the evaluation of water potentials (PMS Instruments). Ion contents were determined with atomic absorption spectrophotometer (Hitachi Z-8200), and stomatal conductances were measured with steady state porometer (PP System).

*Corresponding author. E-mail: galleagnes@msn.com

Results and Discussion

Response of two wheat cultivars to 400mOsm PEG 6000 exposure was measured for 14 days. Water deficit decreased the relative leaf and root growth in both of cultivars. Water potential of the second leaves decreased dramatically in cv. Öthalom during the first week of PEG exposure but after an acclimation period it began to increase. In case of cv. Kobomugi there were smaller reductions in water potential values under PEG treatment. Osmotic potential (Ψ_π) was also measured from the tissues of second leaves. PEG treatment resulted in a substantial decrease of Ψ_π in leaves of Öthalom seedlings while there were no significant changes in the case of Kobomugi. Calculated turgor pressures in the 2nd leaves of Öthalom exhibited a steep decrease in the first week but after two weeks of acclimation it almost reached the value of the control.

Kobomugi could be characterized by a fast stomatal closure in all leaves after exposure to PEG 6,000. The first leaves of Öthalom had smaller evaporation rate than that of Kobomugi, but stomatal closure of PEG-treated plants became significant later than in case of Kobomugi. It can be concluded that regulation of stomatal conductance proved to be more efficient in Kobomugi under water deficit.

Deleterious effects of abiotic stressors on plants can be detected by measuring parameters of fluorescence induction. Water deficit induced by 400 mOs PEG 6,000 did not cause changes in Fv/Fm parameters of dark adapted leaves in the two cultivars which suggested that PSII quantum efficiency did not decline during stress. The quantum efficiency of PSII open centers in light-adapted samples at 180 µmol m^{-2} s^{-1} irradiance decreased significantly in cv. Öthalom, but did not change in cv. Kobomugi under water stress.

We found no significant changes in the rate of photosynthetic electron transport, photochemical and non-photochemical quenching parameters when we used similar intensities in case of the actinic light in the experiments and illuminating light in the growth chamber (180 µmol m^{-2} s^{-1}). At 2200 µmol m^{-2} s^{-1} actinic light intensity higher rate of ETR and fluorescence yield could be detected in the PEG-treated Kobomugi leaves than in the control samples which suggested that in contrast to cv. Öthalom, water stress improved the light stress resistance in Kobomugi.

On the basis of these results we can suppose that the two cultivars cope with water deficit by different strategies. Kobomugi saves tissue water content by fast closure of stomata, maintenance of osmotic potential and photosynthetic activity of leaves, while in Öthalom the increase in resistance begins after a relatively long alarm phase especially in young leaves.

Acknowledgement

This work was supported by a grant from The National Research Development Project (4/038/2001).

References

Blum A (1988) Plant breeding for stress environments. Boca Raton, Florida: CRC Press

Bray EA (1997) Plant responses to water deficit. Trends in Plant Sci 2:48-54.

Dash S, Mohanty N (2001) Evaluation of assays for the analysis of thermotolerance and recovery potentials of seedlings of wheat (*Triticum aestivum* L.) cultivars. J Plant Phys 158:1153-165.