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J. Plant Physiol. 161. 599–609 (2004)
http://www.elsevier.de/jplhp

JOURNAL OF
PLANT PHYSIOLOGY

Dark chilling inhibition of photosynthesis and symbiotic nitrogen fixation in soybean during pod filling

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Received April 3, 2003 · Accepted June 5, 2003

Summary

The growth stage of a soybean [*Glycine max* (L.) Merrill] plant may influence its physiological response to dark chilling. Opposed to vegetative development, the intense nutrient and energy requirements of the developing seeds during pod filling could cause additional chilling damage and decreased recovery capacity. Previously, we investigated dark chilling tolerance during vegetative development in two soybean genotypes, ‹Maple Arrow› and ‹Fiskeby V› and consistently found that photosynthesis and symbiotic nitrogen fixation (SNF) was less affected by dark chilling in ‹Maple Arrow›. In this study we describe the dark chilling response of the same genotypes during pod filling. Our aim was to establish whether the potential selection criteria for dark chilling tolerance, identified during vegetative development, was equally sensitive during pod filling. The results indicate that photosynthesis is less affected by dark chilling in ‹Maple Arrow› than in ‹Fiskeby V›, not only during vegetative development, but also during the critical reproductive stage of pod filling. ‹Fiskeby V› also lacks the ability to restore normal photosynthetic capacity during an extended recovery treatment. The decrease of nodule ureide content indicates that SNF was inhibited to a similar extent in both genotypes. Nodule ureide content was reduced more than stem ureide content, suggesting that the former is a more sensitive indicator of chilling stress effects on SNF. The results indicate that certain photosynthetic and fluorescence parameters are sensitive indicators of dark chilling tolerance throughout plant development and should prove valuable in future breeding programmes aimed at increasing the chilling tolerance of soybean.

Key words: chilling tolerance – chlorophyll *a* fluorescence – dark chilling – *Glycine max* (L.) Merr. – JIP-test – photosynthesis – photosystem II – symbiotic nitrogen fixation – ureides

Abbreviations: A = CO_2 assimilation rate at ambient CO_2 concentration. – A_{max} = maximum CO_2 assimilation rate at saturating CO_2 concentration. – ABS = absorption energy flux. – c_a = atmospheric CO_2 concentration. – c_i = intercellular CO_2 concentration. – CS = excited cross section of leaf sample. – $\partial A/\partial c_i$ = initial slope of demand function. – DI = dissipation energy flux at the level of the antenna chlorophylls. – ET = energy flux of electrons from Q_A^- into the electron transport chain. – FBPase = fructose-1,6-bisphosphatase. – g_s = stomatal conductance. – k_N = nonphotochemical de-excitation rate constant. – k_P = photochemical de-excitation rate constant. – l = relative stomatal limitation. – φ_{Do}

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0176-1617/04/161/05-599 $ 30.00/0