

Separately and simultaneously induced dark chilling and drought stress effects on photosynthesis, proline accumulation and antioxidant metabolism in soybean

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Summary

The effects of separately or simultaneously induced dark chilling and drought stress were evaluated in two *Glycine max* (L.) Merrill cultivars. For the separately induced dark chilling treatment (C), plants were incubated at 8 °C during 9 consecutive dark periods. During the days, plants were kept at normal growth temperatures. For the separately induced drought treatment (D), plants were maintained at normal growth temperatures without irrigation. For the simultaneously induced dark chilling and drought stress treatment (CD), plants were dark chilled without irrigation. All treatments caused similar decreases in pre-dawn leaf water potential, but resulted in distinct physiological and biochemical effects on photosynthesis. In Maple Arrow, where C had the smallest effect on photosynthesis, prolonged CD caused less inhibition of photosynthesis compared to D. Compared to Fiskeby V, the photosynthetic apparatus of Maple Arrow appears to possess superior dark chilling tolerance, a property which probably also conveyed enhanced protection against CD. Proline accumulation was prevented by CD at the Ψ_{PD} where D already resulted in considerable accumulation. The superior capacity for proline accumulation in Maple Arrow would seem to be an important factor in its stress tolerance. Antioxidant activity evoked by CD and D was higher than for C alone. In Fiskeby V, the small increase in ascorbate peroxidase (EC 1.11.1.7) activity, which was in most cases not accompanied by increased glutathione reductase (EC 1.6.4.2) activity, could impact negatively on its stress tolerance. These results demonstrate large genotypic differences in response to chilling and drought stress, even between soybean cultivars regarded as chilling tolerant.

Key words: antioxidant enzymes – dark chilling – drought stress – *Glycine max* (L.) Merr. – photosynthesis – proline accumulation

Abbreviations: A = CO₂ assimilation rate at ambient CO₂ concentration. – A_{max} = maximum CO₂ assimilation rate at saturating CO₂ concentration. – APX = ascorbate peroxidase. – C = separately induced dark chilling. – c_a = atmospheric CO₂ concentration. – CD = simultaneously induced dark chilling and drought stress. – c_i = intercellular CO₂ concentration. – D = separately induced drought stress. – FK = Fiskeby V. – GR = glutathione reductase. – g_s = stomatal conductance. – I = relative stomatal limitation of photosynthesis. – MA = Maple Arrow. – ROS = reactive oxygen species. – Ψ_{PD} = pre-dawn leaf water potential

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