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Salinity Stress Induces Granal Development in Bundle Sheath Chloroplasts of Maize, an NADP-Malic Enzyme-Type C_4 Plant

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Abstract: *Zea mays* is an NADP-malic enzyme (ME)-type C_4 plant. The C_4 plants of this type are attractive species for ultrastructural and physiological studies because they possess reduced grana in bundle sheath cell (BSC) chloroplasts. The present study evaluated the effect of salinity on granal development in BSC chloroplasts of maize. The plants were grown in soil media and after the second leaf was fully developed they were irrigated with four different concentrations (0, 1, 2 and 3%) of NaCl for 5 d. Ultrastructure, quantitative properties of chloroplasts and chlorophyll fluorescence parameters were evaluated. Granal stacking in BSC chloroplasts was induced by treatment with 2 or 3% NaCl. In contrast, granal stacking in mesophyll cell (MC) chloroplasts was reduced and disorganized by the NaCl treatment due to swelling of thylakoid. In control plants, only 2% of grana in BSC chloroplasts contained more than three thylakiods. In the plants treated with 3% NaCl, however, 66% of grana contained more than three thylakoids in BSC chloroplasts. The maximum number of thylakoids in grana of BSC chloroplasts in the control and 3% NaCl-treated plants, was 4 and 16 respectively. The granal index in BSC chloroplasts of 3% NaCl-treated plants was more than three times higher than that in the control plants. Chlorophyll fluorescence parameter analysis showed that the maximal quantum yield (Fv/Fm), the effective quantum yield of PSII (Φ_{PSII}) and PSII-driven electron transport rate (ETR) decreased with the increase of salinity stress. These results suggest that the suppression mechanism of granal development in BSC chloroplasts of maize is influenced by salinity.

Keywords: Bundle sheath, Chlorophyll fluorescence, Chloroplasts, C_4 plant, NADP-malic enzyme, Salinity, *Zea mays* L

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