Drought stress delays photosynthetic induction and accelerates photoinhibition of photosystem I under fluctuating light

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Abstract

Fluctuating light (FL) and drought stress usually occur concomitantly. However, whether drought stress affects photosynthetic performance under FL remains unknown. Here, we measured gas exchange, chlorophyll fluorescence, and P700 redox state under FL in drought-stressed tomato (Solanum lycopersicum) seedlings. Drought stress significantly affected stomatal opening and mesophyll conductance after transition from low to high light and thus delayed photosynthetic induction under FL. Therefore, drought stress exacerbated the loss of carbon gain under FL. Furthermore, restriction of CO2 fixation under drought stress aggravated the over-reduction of photosystem I (PSI) upon transition from low to high light. The resulting stronger FL-induced PSI photoinhibition significantly supressed linear electron flow and PSI photoprotection. These results indicated that drought stress not only affected gas exchange under FL but also accelerated FL-induced photoinhibition of PSI. Furthermore, drought stress enhanced relative cyclic electron flow in FL, which partially compensated for restricted CO2 fixation and thus favored PSI photoprotection under FL. Therefore, drought stress has large effects on photosynthetic dark and light reactions under FL.

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