Modulation of Photosystem II Cyclic Electron Flow by State Transition Regulation in *Chlamydomonas reinhardtii*

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As global temperatures rise and drought conditions become more frequent, agriculture faces increasing strain, necessitating new strategies for crop acclimation to environmental hazards. In some photosynthetic organisms, the poorly characterized process of photosystem II-cyclic electron flow (PSII-CEF) plays a crucial role in protecting the PSII D1 protein under extreme light conditions and bypassing production of reactive oxygen species that cause photoinhibition. State transitions, a well-established process, regulate the exchange of light-harvesting complex (LHC) proteins between PSII and photosystem I (PSI), optimizing energy distribution to their respective reaction centers. By comparing the absorbance and fluorescence spectra between the green alga *Chlamydomonas reinhardtii* and its *stt7* mutant strain, CC-5681, which is trapped in state 1 with its LHC associated to PSII, we can further elucidate the conditional regulation of PSII-CEF. Here we report that linear electron flow through the photosynthetic electron transport chain and the activity of PSI is disrupted by the lack of state transitions, leading to the return of electrons to PSII via backward transitions characteristic of elevated PSII-CEF. Oxygen yield is diminished beyond what is expected from visible center activity, indicating significant PSII inactivation. PSI is expressed at lower levels in the mutant. Electrochromic shift studies indicate that despite conditions favoring minimal PSI-cyclic electron flow activity, the mutant has a stronger pH gradient across the thylakoid membrane, supporting the idea of PSII-CEF as a proton-coupled, energy-transducing process in addition to its photoprotective role.