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Plasticity in roles of cyclic electron flow around photosystem I at contrasting temperatures in the chilling-sensitive plant *Calotropis gigantea*

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Highlights

- We examine the roles of cyclic electron flow at contrasting temperatures.
- Cyclic electron flow mainly favors ATP synthesis at normal growth temperature.
- Cyclic electron flow mainly functions for photoprotection via lumenal acidification.
- Plasticity in roles of CEF is regulated by the activity of thylakoid ATP synthase.

Abstract

Cyclic electron flow (CEF) around photosystem I is thought to balance the ATP/NADPH energy budget and protect photosynthetic apparatus. However, the plasticity in roles of CEF at contrasting temperatures is not well understood. We examined photosynthetic electron flow, non-photochemical quenching (NPQ), PSI redox state, and electrochromic shift (ECS) signal at 25ºC (normal temperature) and 4ºC (low temperature) for leaves of a chilling-sensitive tree species *Calotropis gigantea*. We found that electron flow through PSII (ETRII) was largely depressed at 4ºC irrespective of light condition, whereas CEF was enhanced under light intensities below 500 μmol photons m^{-2} s^{-1} but suppressed under light intensities above 760 μmol photons m^{-2} s^{-1}. Meanwhile, both NPQ and PSI donor side limitation [Y(ND)] were enhanced at 4ºC. Moreover, the relationships between the rate of CEF and values for NPQ