Redox rhythm gates immune-induced cell death distinctly from genetic clock

ABSTRACT

Organisms use circadian clocks to synchronize physiological processes to anticipate the Earth's day-night cycles and regulate responses to environmental signals to gain competitive advantage. While divergent genetic clocks have been studied extensively in bacteria, fungi, plants, and animals, a conserved circadian redox rhythm has been reported only recently. However, its biological function and physiological outputs remain elusive. We uncovered the coexistence of redox and genetic rhythms with distinct period lengths and transcriptional targets through concurrent metabolic and transcriptional time-course measurements in an *Arabidopsis* long-period clock mutant. Analysis of the target genes indicated regulation of the immune-induced programmed cell death (PCD) by the redox rhythm. Moreover, this time-of-day-sensitive PCD was eliminated by redox perturbations and by blocking the signalling pathway of the plant defence hormones jasmonic acid/ethylene, while remaining intact in genetic clock-defective backgrounds. We hypothesize that compared to robust genetic clocks, the more sensitive circadian redox rhythm serves as a signalling hub in regulating incidental energy-intensive processes, such as immune-induced PCD involving reprogramming of chloroplast and mitochondria activities, to provide organisms a flexible strategy to mitigate metabolic overload during stress responses.