BRC Science Highlight
August 2020

Arabidopsis Plants Expressing Only the Redox-Regulated Rca-α Isoform Have Constrained Photosynthesis and Plant Growth

Background/objective

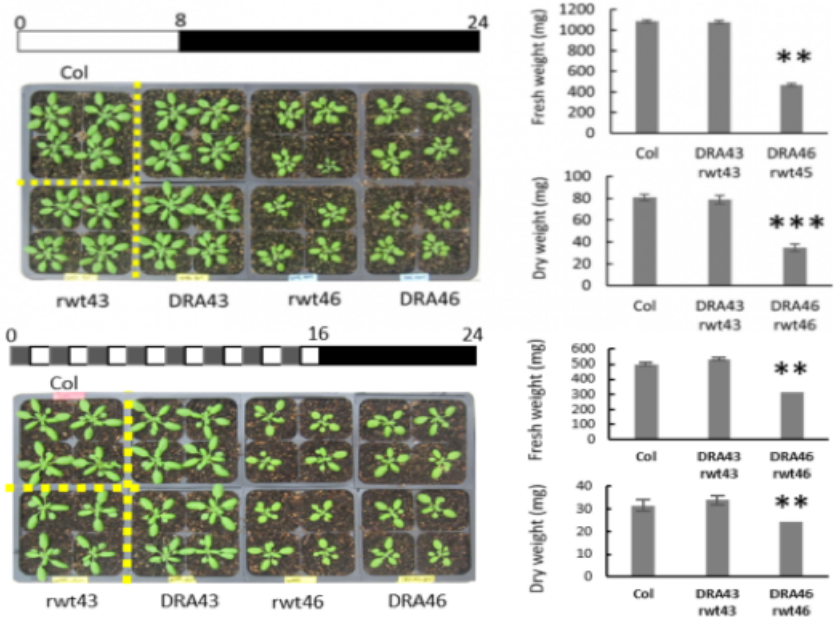
Rubisco activase (Rca) plays a central role in initiating and sustaining Rubisco activation for CO_2 assimilation and photosynthesis. Alternative splicing of a single *Rca* gene in Arabidopsis results in two Rca isoforms, Rca-α and Rca-β, which act together to control Rubisco activation. Previously only one existing transgenic line (rwt46) existed, so a newly generated line (DRA46) was used to broaden the genetic basis. While Rca-α alone, in Arabidopsis, less effectively activates Rubisco *in planta*, this study explores how CO_2 assimilation and plant growth are impacted.

Approach

- New constructs expressing the individual *Rca* isoform transcripts driven by the *RbcS* promoter were created and transformed into the WT (Col-0) before crossing into the *rca* null mutant.
- Plants were grown under four different light conditions to investigate the impact of Rca-α isoform only expression on plant growth, including "long day-high light," "long day-low light," "long day-fluctuating light," and "short day-high light."

Results

- In all conditions except high light intensity in long day photo-periods, rwt46 and DRA46 plants required more days to flower despite similar number of rosette leaves.
- Expression of only Rca-α slowed growth in long day conditions, especially in low light, likely due to reduced carbon assimilation.
- The alternative splicing mechanism generally works for *Rca-α* genes regardless of the origin, plays a role in suppressing Rca-α expression, and may regulate photosynthesis and carbon gain by maintenance of proper ratio between the two isoforms.



Growth phenotypes of Rca-β only (rwt43 and DRA43) and Rca-α only (rwt46 and DRA46) expressing transgenic plants in fluctuating light and in short day photoperiod.

Significance

Our findings suggest that Rca-α alone cannot maintain sufficient Rubisco activation for effective carbon assimilation. Rca oligomers composed of Rca-α only are less effective in initiating and sustaining Rubisco activation than when Rca-β is also present. By learning more about Rca-α's role in plant species, including many C3 and C4 food and bioenergy crops, we can understand how it impacts these plants' ability to adapt to certain environmental conditions, such as heat stress.

Kim, S.Y., et al. 2020. "Arabidopsis plants expressing only the redox-regulated Rca-α isoform have constrained photosynthesis and plant growth." ***The Plant Journal.*** *DOI: 10.1111/tpj.14897.*

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