*BRC Science Highlight*
*November 2020*

# A Role for Differential Rubisco activase Isoform Expression in $C_4$ Bioenergy Grasses at High Temperature

## Background/objective

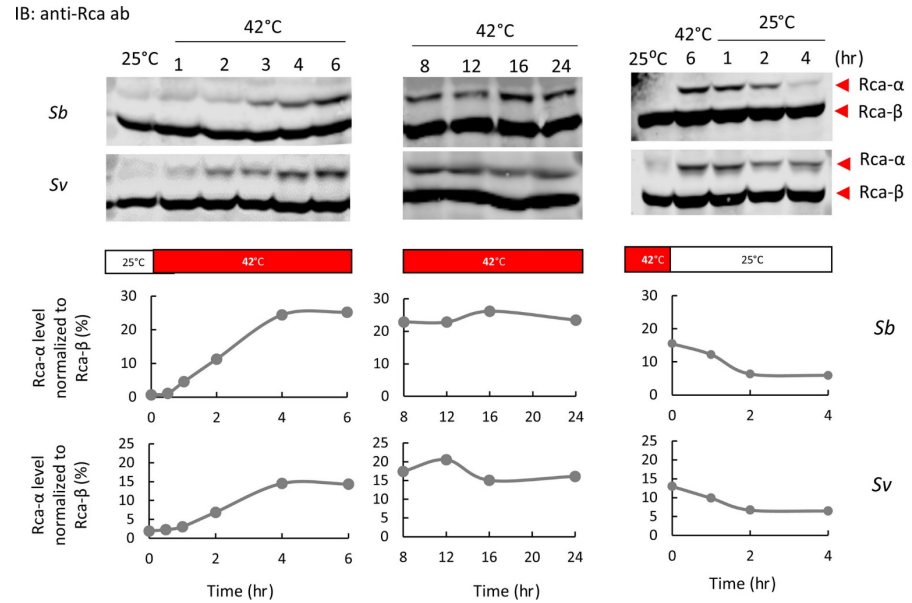
Rubisco activase (Rca) facilitates the removal of inhibitory sugar-phosphates to allow Rubisco activation during $CO_2$ fixation. Most plant species express two Rca isoforms, the larger Rca-α and the shorter Rca-β. While the mechanism of Rubisco activation by Rca isoforms has been intensively studied in $C_3$ plants, the functional role of Rca in $C_4$ plants, where Rubisco and Rca are located in a much higher [$CO_2$] compartment, is less clear. This study selected four $C_4$ bioenergy grasses and the model $C_4$ grass setaria (*Setaria viridis*) to investigate the role of Rca in $C_4$ photosynthesis.

## Approach

- Gene structures and motifs in the promoters of Rca genes were analyzed in four $C_4$ bioenergy grasses (sorghum [*Sorghum bicolor*], maize, sugarcane [*Saccharum officinarum*], and miscanthus [*Miscanthus sinensis*]) and the model C4 grass setaria (*Setaria viridis*).
- Rca isoform expression was analyzed in each of the grasses under various stress conditions (drought, salt, heat, and cold).

## Results

- Key regulatory regions of Rca-α proteins are largely conserved in the five $C_4$ grasses.
- At ambient growth temperature (~25°C), only Rca-β isoforms were expressed, whereas high temperature (~42°C) induced gradual Rca-α isoform accumulation, which again decreased when temperature returned to the growth temperature.
- The Rca-α induction profile was similar to the recovery profile of both $CO_2$ assimilation and Rubisco activation after a shift from ambient to high temperature.




**Immunoblot analysis of the effect of temperature transitions on abundance of Rca isoforms in sorghum and setaria leaves.**

## Significance

Future work using transgenic plants will further explore how Rca-α might play a central role in sustaining photosynthesis in $C_4$ grasses at high temperature by modulating either Rubisco activation activity and/or Rca stability.

*Kim et al. 2020.* "A Role for Differential Rubisco activase Isoform Expression in $C_4$ Bioenergy Grasses at High Temperature." ***GCB Bioenergy***.
*DOI: 10.1111/gcbb.12768*

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