A Role for Differential Rubisco activase Isoform Expression in C4 Bioenergy Grasses at High Temperature

Background/objective
Rubisco activase (Rca) facilitates the removal of inhibitory sugar-phosphates to allow Rubisco activation during CO2 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 C3 plants, the functional role of Rca in C4 plants, where Rubisco and Rca are located in a much higher [CO2] compartment, is less clear. This study selected four C4 bioenergy grasses and the model C4 grass setaria (Setaria viridis) to investigate the role of Rca in C4 photosynthesis.

Approach
- Gene structures and motifs in the promoters of Rca genes were analyzed in four C4 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 C4 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 CO2 assimilation and Rubisco activation after a shift from ambient to high temperature.

Significance
Future work using transgenic plants will further explore how Rca-α might play a central role in sustaining photosynthesis in C4 grasses at high temperature by modulating either Rubisco activation activity and/or Rca stability.

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