A role for differential Rca isoform expression in C4 bioenergy grass thermotolerance?

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Enhancement of crop production of C4 bioenergy grass by modifying posttranslational modification of Rubisco activase

ABSTRACT

Rubisco activase (Rca) facilitates the release of sugar-phosphate inhibitors at Rubisco catalytic sites during CO_2 fixation. Most plant species express two Rca isoforms, the larger Rca-α and the shorter Rca-β, either by alternative splicing from a single gene or from separate genes. The mechanism of Rubisco activation by Rca isoforms has been intensively studied in C3 plants; however, the functional role of Rca in C4 plants exposing Rca to much higher [CO_2] is less clear. In this study, we selected five C4 bioenergy grasses to investigate the role of Rca in C4 photosynthesis. All five C4 plants contained two *Rca* genes, one encoding Rca-α and the other encoding Rca-β, which are closely positioned in the genome. A variety of abiotic stress-related motifs exist in the *Rca-α* promoter of each grass, and while the *Rca-β* gene was constantly highly expressed at ambient temperature, Rca-α isoforms were expressed only at high temperature but surpassed 30% of Rca-β content. The pattern of Rca-α induction upon transition to high temperature and reduction upon return to ambient temperature was the same in all five C4 grasses but may be unique to C4 grasses. In sorghum (*Sorghum bicolor*), the induction rate of Rca-α isoforms was similar to the recovery rates of gas exchange and Rubisco activation from high temperature, which inferred a functional correlation between Rca-α isoform expression and maintenance of Rubisco activation at high temperature. Therefore, our research suggests Rca-α isoforms have a functional role in carbon fixation by supporting Rubisco activation at high temperature.

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