Starch deficiency in plant mutants and its influence on photosynthetic and post-photosynthetic carbon isotope fractionations

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Carbon isotope fractionations occurring during and after CO₂ fixation shape the carbon isotope composition (i.e. d₁³C) of plant material and respired CO₂. However, responses of ₁³C fractionations to diel variation in the leaf starch metabolism are not fully understood. Here we measured d₁³C of organic matter (d₁³COM), concentrations and d₁³C of potential respiratory substrates, d₁³C of dark-respired CO₂ (d₁³CR), and gas-exchange in leaves of starch-deficient plastidial phospho-γ-glucos-μtase (pgm) mutants and wild type plants of four species (Arabidopsis thaliana, Mesembryanthemum crystallinum, Nicotiana sylvestris, and Pisum sativum).

The strongest d₁³C response to the pgm-induced starch deficiency was observed for N. sylvestris, with more negative d₁³COM, d₁³CR, and d₁³C values for assimilates (i.e. sugars, starch) and organic acids (i.e. malate, citrate) in pgm mutants than in wild type plants during a diel cycle. The genotype differences in d₁³C values could be largely explained by differences in leaf gas-exchange. In contrast, the PGM-knockout effect on post-photosynthetic ₁³C fractionations via the plastidic fructose-1,6-bisphosphate aldolase reaction or during respiration was small.

We conclude that the d₁³C changes caused by the pgm-induced starch deficiency are primarily explained by photosynthetic ₁³C fractionations. Our results stress the importance of mutants for studying isotope fractionations in plants.