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Impact of high atmospheric CO_2 concentration on the seasonality of gas exchange and carbohydrate metabolism in coffee trees under field conditions

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Introduction

The effects of climate change on coffee growth and production are particularly concerning given the importance of this commodity. In order to elucidate the mechanisms involved in plant responses, the seasonality of gas exchange and carbohydrate metabolism of coffee were investigated under field conditions, at a Free Air CO_2 Enrichment (FACE) facility for coffee, in Brazil.

Materials/Methods

Coffea arabica L. cv. Catuaí IAC 144 were grown in a FACE System at Embrapa Environment, under ambient (≅400ppm – CO_{2amb}) and high (≅550ppm – CO_{2high}) atmospheric CO_2 concentration. Seasonal leaf gas exchange and carbohydrate compounds were measured using a portable Infra-Red Gas Analyser and a GC/MS system respectively.

Results/Discussion

We show that *C. arabica* trees grown under CO_{2high} conditions exhibited increased photosynthetic rates (averaging 121% higher in summer and 45% higher in winter) in both seasons, without displaying any significant changes in the seasonal photosynthesis pattern. Additionally, there was a tendency for the coffee trees grown at CO_{2high} to exhibit increased levels of soluble carbohydrates, organic acids and amino acids in the leaves.

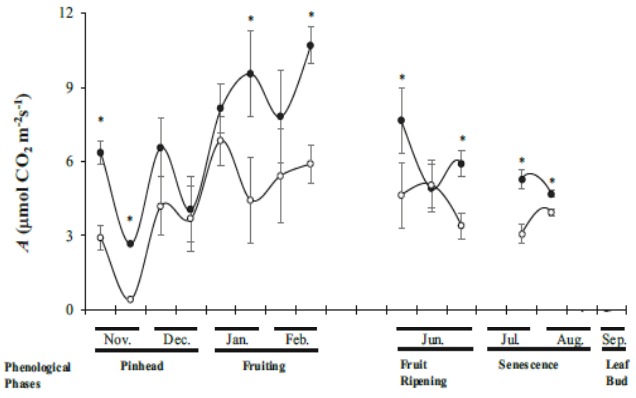

Figure 1: Photosynthetic rates (*A*, μmol CO_2 m^2 s^{-1}) under light intensity of 600 μmol photons m^2 s^{-1}, in leaves of *C. arabica* grown at: ≅400 μmol mol^{-1} CO_2 (o) and ≅550 μmol mol^{-1} CO_2 (●). Bars indicate the standard deviation of the mean (n = 3). Asterisks (*) signify values that were determined to be statistically different as assessed by the Tukey test at the 5% probability level.

Conclusion/Perspectives

Our findings suggest that coffee trees adapt to CO_{2high} through increased photosynthetic rates, enhanced stomatal conductance regulation and augmented carbohydrate and organic acid synthesis. It is plausible that these features could help mitigate the effects caused by climate change. These results should be considered when preparing impact assessments and when developing cultivation strategies for the anticipated increase in [CO_2].

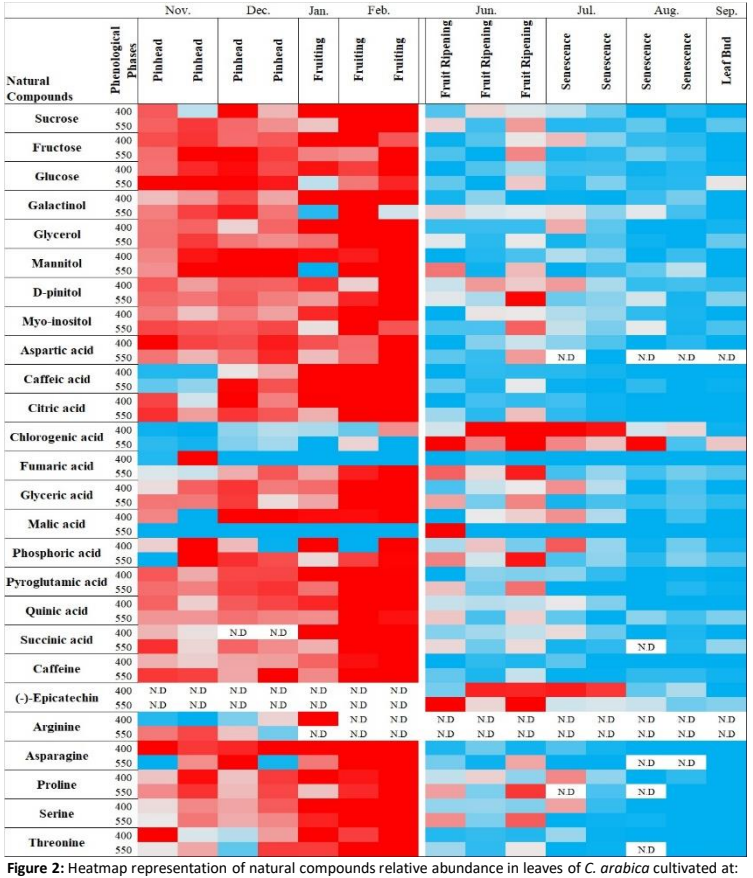

Figure 2: Heatmap representation of natural compounds relative abundance in leaves of *C. arabica* cultivated at: ≅400 μmol mol^{-1} CO_2 and ≅550 μmol mol^{-1} CO_2. The values of the compounds displayed with gradients of blue (■ – values below average), gray (■ – average values) and red (■ – values above average). N.D - Not Detected. All data were normalized to 1.

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