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Impact of water availability constraints on photosynthetic activity in elite genotypes of *Coffea arabica* L. and the mitigating effect of elevated atmospheric [CO_2]

Joana I. MARTINS[1,2] (jis.martins@campus.fct.unl.pt), Ana P. RODRIGUES[1], Isabel MARQUES[1], José N. SEMEDO[2,3], Isabel P. PAIS[2,3], Maria J. SILVA[1,2], António E. LEITÃO[1,2], Fernando C. LIDON[2], Ana I. RIBEIRO-BARROS[1,2], José C. RAMALHO[1,2]

[1] PlantStress&Biodiversity Lab, Centro de Estudos Florestais, Laboratório Associado TERRA, Instituto Superior de Agronomia, Universidade de Lisboa, 2784-505 Oeiras, e 1349-017 Lisboa, Portugal. [2] Unidade de Geobiociências, Geoengenharias e Geotecnologias, Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa, 2829-516 Caparica, Portugal. [3] *Unidade de Investigação em Biotecnologia e Recursos Genéticos, Instituto Nacional de Investigação Agrária e Veterinária, I.P. (INIAV), Quinta do Marquês, Av. República, Oeiras, 2784-505, Portugal.*

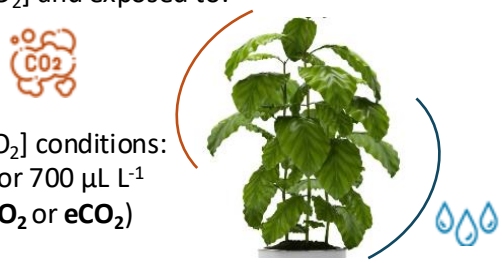
jis.martins@campus.fct.unl.pt

INTRODUCTION

Drought threatens coffee crop sustainability, and unveiling its impact and plant resilience on the photosynthetic pathway is crucial [1]. Elevated [CO_2] partly counteract the negative impacts of water deficit on coffee plants, namely by enhancing net photosynthesis (P_n) via increased ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO) substrate availability [2]. Here, we assessed the extent to which drought affects the photosynthetic performance of *Coffea arabica* L. genotypes, under normal (aCO_2) and high (eCO_2) air [CO_2].

MATERIALS/METHODS

Plants from *C. arabica* L. *cvs*. Geisha 3 (**G3**), Marsellesa (**Mar**), and their Hybrid (**Hy**) were grown under distinct air [CO_2] and exposed to:



Air [CO_2] conditions: 400 or 700 µL L^{-1} (**aCO_2** or **eCO_2**)

Well-watered (**WW**), Mild drought (**MWD**), Severe drought (**SWD**) and Recovery period (**Rec14**)

The total activity of RuBisCO was performed in the leaf samples through spectrophotometric analysis [2]

CONCLUSIONS

- Water deficit significantly limits *C. arabica* photosynthesis, but eCO_2 can attenuate the adverse effects.
- Recovery patterns suggest varying resilience among genotypes, offering insights into climate acclimation ability.

RESULTS/DISCUSSION

The decline of water availability gradually reduced P_n and stomatal conductance (g_s) regardless of genotype and [CO_2]. Under aCO_2, internal [CO_2] (C_i) increased at SWD, suggesting the dominance of non-stomatal limitations to photosynthesis. The enzyme RuBisCO has been indicated as an important component in the resilience response to adverse environmental conditions [2]. The total activity of RuBisCO declined under MWD and SWD (vs. WW) at both [CO_2] levels, though G3 and Hy showed slightly higher activity under SWD than MWD. Notably, eCO_2 mitigated drought impacts across genotypes, enhancing P_n as compared to aCO_2: G3 (WW: 39%; MWD: 26%; SWD: 213%); Mar (WW: 59%; MWD: 79%; SWD: 15%); Hy (WW: 58%; MWD: 70%; SWD: 250%). Contrary to other genotypes [3], these genotypes showed only a partial recovery of P_n and g_s by Rec14, despite an almost full recovery for RuBisCO activity, with a slightly better recovery under eCO_2.

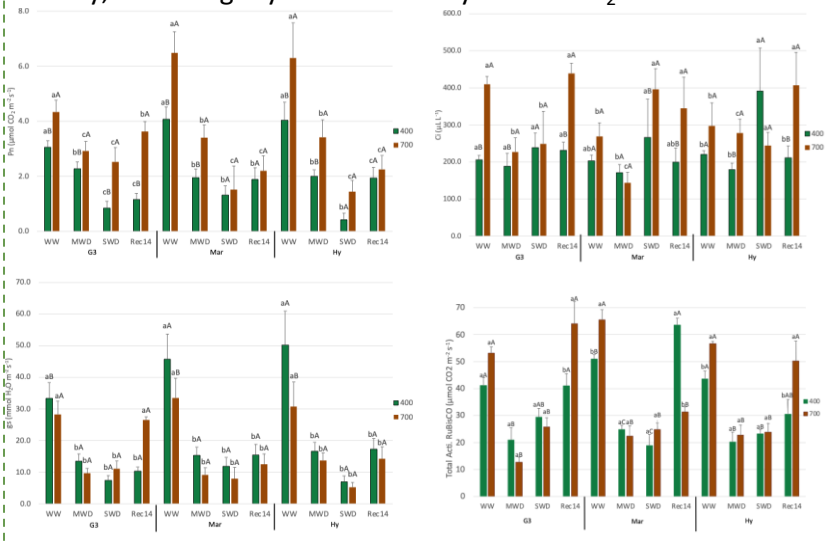


Figure 1. Net photosynthetic rate (P_n) (A), stomatal conductance (g_s) (B), internal [CO_2] (C_i) (C) and total activity of RuBisCO (D) in *Coffea arabica* L. cv. Geisha 3 (G3), Marsellesa (Mar) and their Hybrid (Hy) grown under ambient (400 µL L^{-1}, aCO_2) or elevated (700 µL L^{-1}, eCO_2) air [CO_2], and submitted to well-watered (WW), mild drought (MWD), severe drought conditions (SWD) and recovery period (Rec14). For each parameter, different letters after the mean values ± SE (n = 5) express significant differences between water treatments within each [CO_2] (a, b, c), or between [CO_2] within each water treatment (A, B), always separately for each genotype.

References:

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