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Hormonal crosstalk during the reproductive stage of *Coffea arabica*: interactions among gibberellin, abscisic acid, and ethylene

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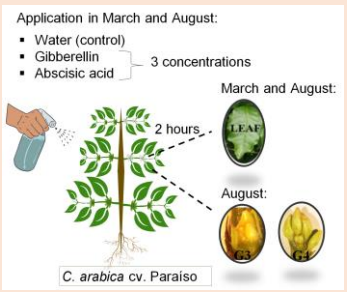
Introduction

The hormonal control of reproductive development in perennial species with complex phenological cycles, such as *Coffea arabica* L., is still poorly understood. Given the economic relevance of coffee and the challenges imposed by climate change, elucidating key hormonal regulators of flowering is essential to improve yield and productivity.

Materials/Methods



The effects of GA and ABA (5, 25, 100 ppm) on *C. arabica* reproductive development were evaluated by phenological and molecular analyses. Gene expression (biosynthesis, degradation, signaling), *CaFT* promoter characterization, ACC quantification, ACO activity, and ethylene levels were assessed in leaves and floral buds during induction and development stages.

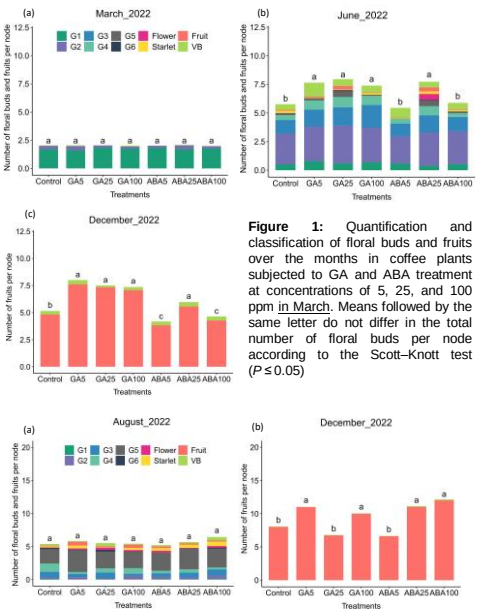


Figure 1: Quantification and classification of floral buds and fruits over the months in coffee plants subjected to GA and ABA treatment at concentrations of 5, 25, and 100 ppm in March. Means followed by the same letter do not differ in the total number of floral buds per node according to the Scott–Knott test ($P \leq 0.05$)

Figure 2: Quantification and classification of floral buds over the months in coffee plants subjected to GA and ABA treatment at concentrations of 5, 25, and 100 ppm in August. Means followed by the same letter do not differ in the total number of floral buds per node according to the Scott–Knott test ($P \leq 0.05$)

Figure 3: The image shows different morphologies of coffee tree branches representing different treatments, with photos captured in June 2022.

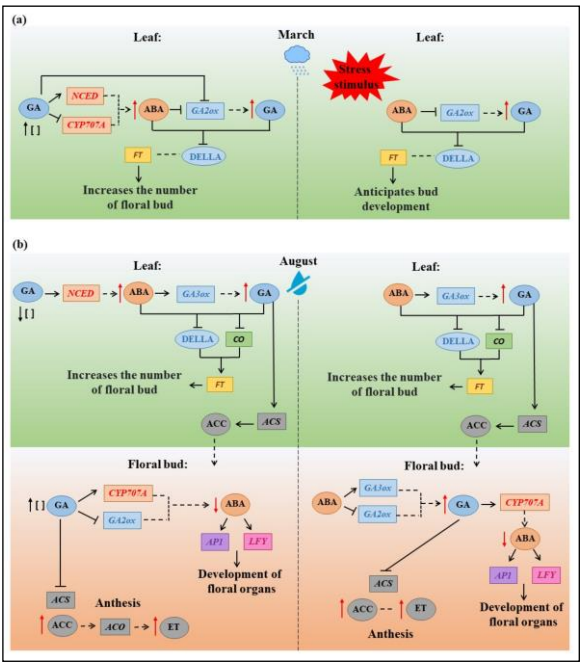


Figure 4: Proposed model for regulating the molecular pathways involved during the floral induction stage in March (a) and in the floral bud development stage in August (b) in *C. arabica* under the application of gibberellin (GA) and abscisic acid (ABA). The green frame represents leaves. The red frame represents floral buds. The square boxes represent genes. The ellipses represent the hormones, ACC and DELLA proteins. Solid lines indicate induction, dashed lines indicate possible regulation not proven in this study, and the T-end of the arrows indicates inhibition. The red arrows indicate increases or decreases. Where [] represents the concentration. The environmental changes associated with water are represented by an image above the tables: March (rainy season) and August (dry season). ABA: Abscisic acid; ACC: 1-aminocyclopropane-1-carboxylic acid; ACS: ACC SYNTHASE; ACO: ACC OXIDASE; *AP1: APETALA 1; CO: CONSTANS; CYP707A: CYTOCHROME P450, FAMILY 707, SUBFAMILY A*; ET: ETHYLENE; *FT: FLOWERING LOCUS T*; GA: Gibberellin; *GA2ox: GIBBERELLIN 2-OXIDASE; GA3ox: GIBBERELLIN 3-OXIDASE; LFY: LEAFY; NCED: 9-CIS-EPOXY CAROTENOID DIOXYGENASE.*

Results/Discussion

GA (all doses) and ABA (25 ppm) applied during floral induction (March) increased bud number, with ABA also accelerating development. In later stages (August), GA (5 and 100 ppm) and ABA (25 and 100 ppm) promoted bud formation and fruit set. Molecular analyses revealed modulation of flowering-related genes and suggested a GA-ACC-ethylene interaction regulating anthesis.

Conclusion/Perspectives

GA and ABA reciprocally regulate coffee reproductive development in a dose-dependent manner, interacting with ethylene. These advancements in understanding hormonal crosstalk provide bases for improved agronomic practices and breeding strategies to optimize coffee production under changing environments.

References:

Azevedo, L.M., de Oliveira, R.R., dos Reis, G.L. et al. Hormonal crosstalk during the reproductive stage of *Coffea arabica*: interactions among gibberellin, abscisic acid, and ethylene. Planta 261, 110 (2025). https://doi.org/10.1007/s00425-025-04679-0