Addressing climate change in coffee farming: development of a methodology to select for drought tolerance in coffee varieties

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Olivier Darracq[1] , Sophie Léran[2] , Hafid Aberkane[1] , Algenis Palacios[3] , Jonny Castillo[3] , Mélanie Bordeaux[3] , Lison Marie[2] , Fabrizio Arigoni[1] , Hervé Etienne[2] , Benoit Bertrand[2] , Pierre Marraccini[2]
[1] Nestlé Research Center, Tours, France ; [2] CIRAD, UMR DIADE, Montpellier, France ; [3] Nicafrance Foundation, finca La Cumplida, Matagalpa-Nicaragua

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Introduction

Climate change affects coffee production worldwide. Drought periods are observed more frequently, and the annual precipitations are more unpredictable in many coffee producing countries (Bilen et al. 2022). In this context, breeding for drought tolerant varieties is needed to sustain future production. However, drought tolerance is a complex trait which requires the combination of different disciplines to improve selection efficiency. With the aim to propose a universal methodology to phenotype *C. arabica* and *C. canephora* for drought tolerance, Nestlé, CIRAD and FNF initiated a multidisciplinary project (MADGIC) to define rapid, reliable and cost-effective phenotyping approach for both controlled and semi-controlled conditions.

Materials/Methods

A contrasted set of *C. arabica* and *C. canephora* genotypes were tested under controlled conditions (France) and semi-controlled conditions (Nicaragua) -Cf. Fig. 1- using a common protocol. Coffee plants were subjected to water withdrawal and compared to irrigated plants (unstressed control) - Cf. Fig. 3- to assess the response to drought.

Plants were phenotyped using visual scoring, morphological, and physiological measurements. These traits were collected at the beginning of the experiment, during drought stress and recovery period. Data was analyzed to identify the most discriminant traits in each experiment.

MADGIC (Coffee MAle sterility Drought GenomIC) – Drought workpackage

Figure 1: Pictures of the experiments in France and Nicaragua.

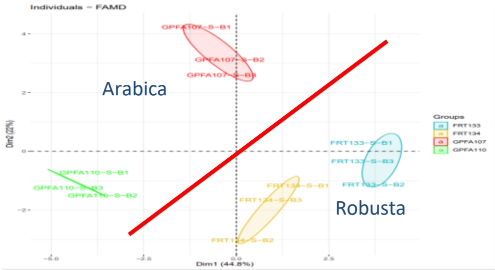

Figure 2: PCA biplot showing the difference in response between *C. canephora* (Robusta) and *C. arabica* genotypes exposed to hydric stress.

	Arabica	Robusta
Traits in common	Visual Drought Score: DS Leaf Area: LA	
Specific traits	Selected Branch Leaf Number: SBLN	Specific Leaf Area: SLA
Field adaptability	Visual Drought Score: DS Selected Branch Leaf Number: SBLN	

Table 1: subset of proposed traits to be followed in semi-controlled conditions.

Results/Discussion

The initial results showed that the two species responded differently to drought stress, with Arabica being more susceptible than Robusta (Cf. fig. 2).
Furthermore, the phenotyping allowed to discriminate susceptible and tolerant genotypes within species (Cf. fig. 2).

The traits were ranked according to their contribution on the PCA axis to discard the less informative and redundant traits. .
Some traits such as visual drought score (DS) and leaf area (LA) are suitable for early screening of large populations, while others such as Selected Branch Leaf Number (SBLN) or DS can also be recommended in the field for long term evaluation of drought (Cf. table 1).

Additionally, the Near InfraRed Spectrometry (NIRS) showed a good potential to predict leaf water content, which is a good indicator of the hydric status of stressed plants. the NIRS portability makes it useful to screen large number of plants in the field.

Conclusion/Perspectives

A limited number of data recording taken at the right time was sufficient to follow the establishment of drought and select tolerant coffee candidates. The phenotyping methodology that is under development will combine low cost, portable tools to be deployed in different testing conditions.

References:

Bilen, C., El Chami, D., Mereu, V., Trabucco, A., Marras, S., & Spano, D. (2022). A Systematic Review on the Impacts of Climate Change on Coffee Agrosystems. Plants, 12(1), 102.