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

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Rationale:
Climate change is posing many challenges that are affecting coffee production worldwide. Among them, drought periods are observed more frequently, and the annual precipitation are becoming more unpredictable in many coffee producing countries. In this context, breeding for drought tolerant varieties is becoming necessary to sustain future coffee production. However, drought tolerance is a complex trait which requires the combination of different disciplines to improve selection efficiency. With the aim to define a universal methodology to phenotype *C. arabica* and *C. canephora*for drought tolerance, Nestlé and CIRAD initiated a multidisciplinary project to define reliable traits to assess coffee drought tolerance rapidly and cost-effectively in both controlled and field conditions. The outcomes of the project Madgic will be a list of reliable traits that could be used.

Methods:
A contrasted set of *C. arabica* and *C. canephora* genotypes were tested under controlled conditions (France) and semi-controlled conditions (Nicaragua) using a common protocol combining visual annotation, detailed phenotyping and physiological analyses. After a period of acclimatization, coffee plants were subjected to water withdrawal and compared to irrigated plants (unstressed control). Morphological and physiological traits were collected at the beginning of the experiment, during drought stress and recovery period. Data were analyzed to study the drought effects on different traits, and to subset the most discriminant traits in each experiment.

Results:
The results showed that our experimental dispositive allowed to discriminate the two coffee species tested. In fact, they responded differently to drought, *C. arabica* cultivars being generally more sensitive to drought than tested *C. canephora*clones. Some traits associated with leaf number and area, were more affected by drought than others, and consequently appeared more powerful to identify tolerant and susceptible plants. The results also showed Near Infra-Red (NIR) as a powerful non-destructive proxy to monitor the leaf water content.

Conclusions & Perspectives:
A phenotyping methodology is proposed combining low cost, portable tools to be deployed in different testing conditions. Some traits such as the total leaf number and leaf area, leaf inclination are suitable for early screening of large populations, while others (selected branch leaf number, NIR, drought visual score) can also be recommended in the field for long term evaluation of drought. A limited number of data recording taken at the right time appeared sufficient to follow the establishment of drought and select tolerant coffee candidates coping this stress.