Genetic-environment interactions and climatic variable effects on bean physical characteristics and chemical composition of *Coffea arabica* F1- hybrids in Vietnam

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Rationale:
Coffee bean chemical compounds and quality depends on genetic factors which opens opportunities to breed genotypes for better quality. F1-hybrids developed by CIRAD and ECOM in the last decades have shown better bean physical characteristics and better sensory quality. The genetic factors interact with environmental ones, and hence this interaction also has an impact on coffee chemical composition and beverage quality. Climate change is predicted to decrease globally the areas suitable for coffee cultivation, and to create new frontiers for coffee management. However, the effects of climate change on coffee quality in these frontier areas with suboptimal conditions are still largely unknown.

Methods:
The effects of the environment and genotype in the coffee bean chemical composition were studied using nine trials covering an altitudinal gradient [600–1100 m above sea level (m.a.s.l.)] with three genotypes of *Coffea arabica* in the northwest mountainous region of Vietnam. The impacts of the climatic conditions on bean physical characteristics and chemical composition were assessed.

Results:
We showed that the environment had a significant effect on the bean density and on all bean chemical compounds. The environment effect was stronger than the genotype and genotype-environment interaction effects for cafestol, kahweol, arachidic (C20:0), behenic acid (C22:0), 2,3-butanediol, 2-methyl-2-buten-1-ol, benzaldehyde, benzene ethanol, butyrolactone, decane, dodecane, ethanol, pentanoic acid, and phenylacetaldehyde bean content. A 2 °C increase in temperature had more influence on bean chemical compounds than a 100 mm increase in soil water content. Temperature was positively correlated with lipids and volatile compounds. With an innovative method using iterative moving averages, we showed that correlation of temperature, vapor pressure deficit (VPD) and rainfall with lipids and volatiles was higher between the 10th and 20th weeks after flowering highlighting this period as crucial for the synthesis of these chemicals. Genotype specific responses were evidenced and could be considered in future breeding programs to maintain coffee beverage quality in the midst of climate change.

Conclusions & Perspectives:
This first study of the effect of the genotype–environment interactions on chemical compounds enhances our understanding of the sensitivity of coffee quality to genotype environment interactions during bean development. This work addresses the growing concern of the effect of climate change on specialty crops and more specifically arabica coffee.

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