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Linking Physiological Response to Shade with Growth and Yield in Different Coffee Agroforestry Systems in Ecuadorian Amazonia

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Abstract

We assessed how agroforestry shade cover, shade types and farming practices affected *Coffea canephora* (robusta) growth, physiology and yield at 5 years old, in Ecuadorian Amazonia. We hypothesised that shade would increase chlorophyll concentrations, further enhanced by nitrogen-fixing trees and would consequently increase yields. The experiment was planted in 2015 and the five treatments were 1) full sun; 2) *Myroxylon balsamum*; or two N-fixing trees 3) *Inga edulis*; 4) *Erythrina* spp. or 5) *Erythrina* spp. plus *M. balsamum*. Four farming practices assessed were: conventional farming at either 1) moderate or 2) intensified input and organic farming at 3) low or 4) intensified input. The experiment was a RCBD with 20 treatment combinations, replicated three times. Each plot was zoned according to distance from the nearest shade tree and measurements were weighted according to the prevalence of each zone in order to compute plot means. Shade cover above coffee was assessed with an MP-200 pyranometer on 4 coffee plants for each zone defined in 2018. Two chlorophyll measurements were made per leaf and four leaves per branch in 2 pairs of leaves at the middle third of the branch with an MP-100 chlorophyll meter. One branch was measured per plant, which resulted in 8 measures per plant on 18 plants per plot. Berry yields are being measured and will be completed in June 2020.

Coffee trees were, on average, taller under the N-fixers, *Inga edulis* and *Erythrina*, than in either the full sun control or under other treatments. Chlorophyll concentrations in coffee leaves ranged from 410 to 581 $\mu\text{mol m}^{-2}$, showing a strong, positive relationship with shade level ($r^2=0.61$). They were highest in the *Inga edulis* and *Erythrina* treatments and lowest in the full sun. Initial results suggest that shade, particularly with N-fixing trees, leads to higher leaf chlorophyll content. Early partial coffee berry yields were 22% higher under full sun than in the agroforestry treatments, regardless of shade tree species. No correlation was found between early yield and leaf chlorophyll content but final yields will only be available in June 2020.

Keywords: Chlorophyll concentration meter, Ecuadorian Amazon region, growth, pyranometer, robusta agroforestry system, shade, yield