

Coffee a Shade-Adapted Plant: Implications on its Carbon Balance and Consequences on Coffee Yield and Quality in Agroforestry Systems

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SUMMARY

Coffee has been classified as a shade-adapted plant species and exhibits typical features of such species: (i) acclimation of leaves in order to photosynthesize in low light, (ii) high leaf area: woody structure ratio and (iii) absence of a self-thinning mechanism that regulates fruit load. These features are of key importance for understanding the acclimation of coffee plants to the shade environment imposed by agroforestry systems because they affect the plant carbon balance, the basis of coffee yield and quality. A trial was established in a commercial coffee plantation under the optimal coffee cultivation conditions of the Orosi valley in Costa Rica by applying four shading regimes and four fruit load levels within each shading regime. In parallel, high and low fruit load treatments were established on girdled coffee branches. Gas exchange and chlorophyll fluorescence measurements, biometrical and biochemical measurements were performed and used to (i) parameterize a leaf carbon assimilation (A) model and (ii) calculate the carbon balance at the branch level. Our results showed that coffee leaves acclimated to efficiently photosynthesize under very low light in shading treatments. It was demonstrated that the light-saturated A was reduced in case of low fruit demand and that this reduction was related to the accumulation of photosynthetic products in the leaves. Because the flower initiation was reduced by shade, this effect was more important in shaded treatments. On the other hand, full sun grown coffee had a high carbon demand by fruits which resulted in a carbon shortage leading to reduced bean size and vegetative growth, thereby hampering the flowering and production potentials for the next season.