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Microenvironment and Leaf Traits Regulate Transpiration of Cocoa (*Theobroma Cacao* L.) under Different Cultivation Systems

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Abstract

The response of plant species to environmental conditions influences changes in functional traits associated with the process that determines biological fitness and ecosystem processes. Thus, the variation of functional traits will be associated with the gradient of variation in environmental conditions. However, documenting these responses remain largely elusive in agroecological cultivation systems. We analyzed, how do cultivation systems influence changes in environmental variables and leaf traits? and how do leaf traits and environmental variables influence the transpiration rate of cocoa trees under different cultivation systems? Fieldwork was carried out at the Sara Ana experimental station in Alto Beni, La Paz, Bolivia. We sampled four trees in each of eight plots; four plots for each cultivation system (organic monoculture vs. organic agroforestry). From each tree, two mature, sunlit and healthy leaves were collected to make measurements of leaf traits (i.e., leaf area, specific leaf area, leaf relative water content, stomatal density and stomata size), environmental variables (i.e., canopy cover, temperature, and absolute air humidity) and transpiration rate. We found that canopy cover was higher in the agroforestry than monoculture systems. Temperature and absolute air humidity were similar between cultivation systems. The specific leaf area was greater in agroforestry systems but the stomata size and transpiration rate were both significantly higher in monoculture systems. The leaf relative water content was slightly higher in agroforestry systems and no differences were found between cultivation systems for stomata density. Temperature had a positive relationship with transpiration rate in both cultivation systems, whereas canopy cover and specific leaf area had a negative relationship in the agroforestry system. Our results suggest that cultivation system caused changes in microenvironmental conditions and on the expression of morphological and physiological leaf traits that regulate water flow through the plant. Cocoa plants have reduced the transpiration rate in agroforestry systems due to the mutual effects of canopy cover, larger leaves and smaller stomatal size. Consequently, agroforestry systems could be used as an adaptative strategy to minimise the negative effects of higher temperatures and less humidity in the context of climatic change.

Keywords: Agroforestry, canopy cover, specific leaf area, stomata size, temperature

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