

Water use characteristics of cocoa (*Theobroma cacao*, L.) in different production systems and of two shade tree species in Alto Beni, Bolivia

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Zusammenfassung

Reduced water availability due to climate change and deforestation will challenge agriculture in the tropics in future. This may also affect the water availability for cocoa (*Theobroma cacao*) production in Bolivia. Cocoa is cultivated shaded or in full sun, as well as under conventional and organic management. Knowledge about the water use characteristics of crops in different production systems and about multipurpose shade tree species is a crucial precondition to adapt to changing conditions. This study aimed at:

- (1) assessing the influence of the cocoa production systems on the water use and water availability of the cocoa and
- (2) analyzing and comparing the water use characteristics of two multipurpose tree species in multistrata agroforestry systems, *Bixa orellana* and *Centropogon ochroxylum*.

The study was conducted in 2011 at the experimental cocoa research site Sara Ana, in Alto Beni, Bolivia, established by the FiBL (Research institute for Organic Agriculture). The region has a tropical climate with one dry season, 1540 mm annual precipitation, 80 % relative humidity, and a mean temperature of 24.9 °C. The soil is predominantly stagnic lixisols. Cocoa is cultivated in five different production system: full sun monoculture and agroforestry system, both under organic and conventional management, respectively, and successional agroforestry system. The latter is a high diversified agroforestry system, basing on the successional stages of species, with an organic management. The multipurpose tree species were growing in the successional agroforestry system: *C. ochroxylum*, a leguminous timber species, and *B. orellana*, whose seeds have economic importance as coloring agents. The leaf transpiration was measured with a steady state parameter and the leaf water potential was determined with a pressure chamber. Both methods were applied in the course of a day on three trees each. In

agroforestry system under organic and conventional management cocoa leaves transpired less than in monocultures when the temperature exceeded 30 °C. An exception was the successional agroforestry system, where transpiration was highest while evaporation was lower than in the other p systems. The cocoa did not experience water stress in none of the production systems, indicated by a low negative leaf water potential and recovering over night. Cocoa trees in all five production systems did not differ in their height and diameter, while crown area was highest in the conventionally managed agroforestry system. *B. orellana* had a higher transpiration rate than *C. ochroxylum*, which can be related to a larger crown area of *B. orellana* at this initial phase of the stand. While none of the multipurpose trees suffered water stress, *C. ochroxylum* had a lower leaf water potential than *B. orellana* and cocoa at forenoon. Conventional and organic management of cocoa did not show differences in the water use characteristics of cocoa. Also the influence of shade trees on the water use and water availability of cocoa was low. In terms of water use none of the multipurpose tree species can be preferred to the other one in this phase of the stand. But transpiration rate, leaf water potential, and water requirements, as well as competition for water or complementarity in water use of cocoa and the agroforest trees may change, when the trees will have reached their final height, crown size, and rooting system.