

Photosynthesis and Water Use of Wild *Coffea arabica* Populations along Climatic Gradient *in situ* and under Stress in an *ex situ* Experiment

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SUMMARY

Ethiopia is the center of genetic diversity of *Coffea arabica*. The CoCE project (Conservation and use of wild populations of *Coffea arabica* in the montane rainforests of Ethiopia) aims at assessing the diversity and the economic value of the Ethiopian coffee gene pool and developing concepts of model character for conservation and use of these genetic resources. Thereby it focuses on traits inherent to the wild coffee populations and their possible usefulness for breeders. In our study, we compared the water use of different populations of four wild *Coffea arabica* populations along a rainfall gradient in Ethiopia. Measurements were carried out *in situ*, as well as in an extended experiment at Jimma Agricultural Research Center, where seeds of the four original sites were used to raise seedlings. Measurements tackled all relevant parts of water transport, i.e. soil conditions, the hydraulic conductivity of the root and the shoot system, stomatal control of gas exchange, and the atmospheric demand for water vapour. Water use efficiency *in situ*, measured by isotopes as well as by gas exchange, was found to be higher in the dry than in the wet season, and on dry sites compared to wet sites, thus reflecting the availability of water. Unexpectedly, no correlation with the rainfall gradient was observed neither when measuring the hydraulic system *in situ*, nor when looking at the reaction of seedlings to drought and radiation stress under *ex situ* conditions. Plants from the driest site, Harennna, showed highest transpiration and production. While the root system of Harennna trees was the most extensive compared to the other sites, also the hydraulic system showed the highest efficiency for water transport, and stomatal behaviour was liberal. As a consequence these plants were the most vulnerable ones to drought stress, and eventually they were the first of all to be damaged and to die during an extended drying period. Plants from the wettest site were much more conservative in terms of water use and withstood much longer against drought stress, at the same time having lower productivity. The results showed that the precipitation gradient was not reflected in a simple way by drought stress tolerance of trees. It can be concluded that populations follow different strategies when conserving or spending water under drought stress conditions. Harennna populations might find their way out of serious droughts by putting their main effort into seed production (and thus conserving the population as a whole), while trees from other populations seem to be more oriented to ensure survival of the individuals. The study shows that different wild coffee populations have interesting traits for breeders, many of them still likely to be unknown. The results also underline that conserving the Ethiopian mountaineous rain forests is the only way to conserve these traits.