Ecophysiological characterization of macadamia orchards in Limpopo, South Africa

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BACKGROUND

South Africa is the largest producer and exporter of macadamia nuts (59,050 tons NIS in 2019). A rapid **expansion of irrigated macadamia production areas** is occurring in the country: 5,962 new hectares were planted in 2019 (SAMAC, 2020).

There is still limited literature describing the physiology of macadamia trees and the **interactions of genotype, environment and management (G x E x M)** in macadamia orchards.

Climate change poses a serious threat to the macadamia production in South Africa, especially in terms of **water availability** and extreme temperatures.

Aim of this study is to increase understanding about and gain new insights on the water relations of macadamia orchards and to apply and extrapolate this knowledge to **increase the water use efficiency** of macadamia cultivation in South Africa by improved seasonal and temporal targeted irrigation.

DATA

The experiment was set up in July 2019 and data collection started from August 2019 – still running

Soil samples were taken before the start of the experiment for the determination of **soil texture**, **bulk density**, **pH**, **electrical conductivity**, **organic C**

Continuous recording of:

- **weather** data: rainfall, throughfall, temperature, relative humidity, solar radiation and wind speed
- **soil moisture**: at 20 and 50 cm depth (TDR); weekly recording of soil moisture along the entire profile (up to 1.6 m; Diviner2000 probe)
- **sap flow** (for the calculation of tree transpiration and daily water use)

Periodic monitoring of:

- tree **phenological development** (leaf area density, number of racemes and nuts per tree)
- tree **morphology** (canopy volume, stem diameter, LAI, leaf inclination)

Measuring **leaf water potential** throughout the day in different seasons and phenological stages

Yearly recording of **production** and **nut quality** (sound kernel recovery %)

Continuous monitoring of **orchard management** (irrigation and pruning)

APPROACH

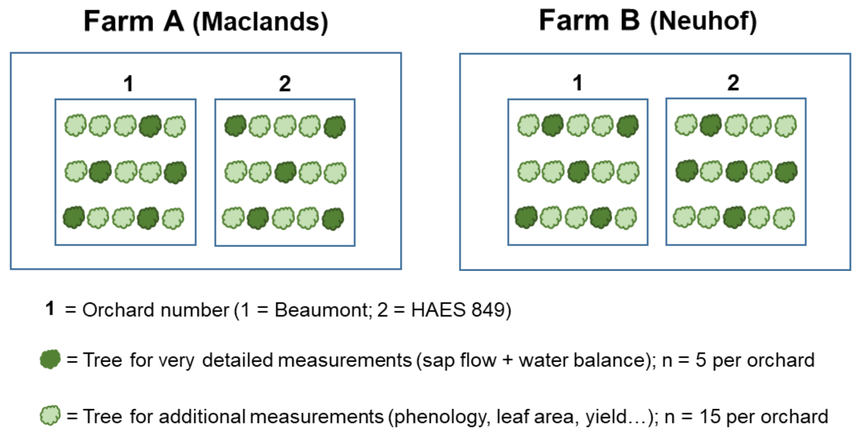
Study design:

2 farms (Maclands and Neuhof) x **2 orchards** x **2 varieties** (Beaumont and HAES 849)

Orchards with similar tree age, soil characteristics (soil texture), topography, orientation

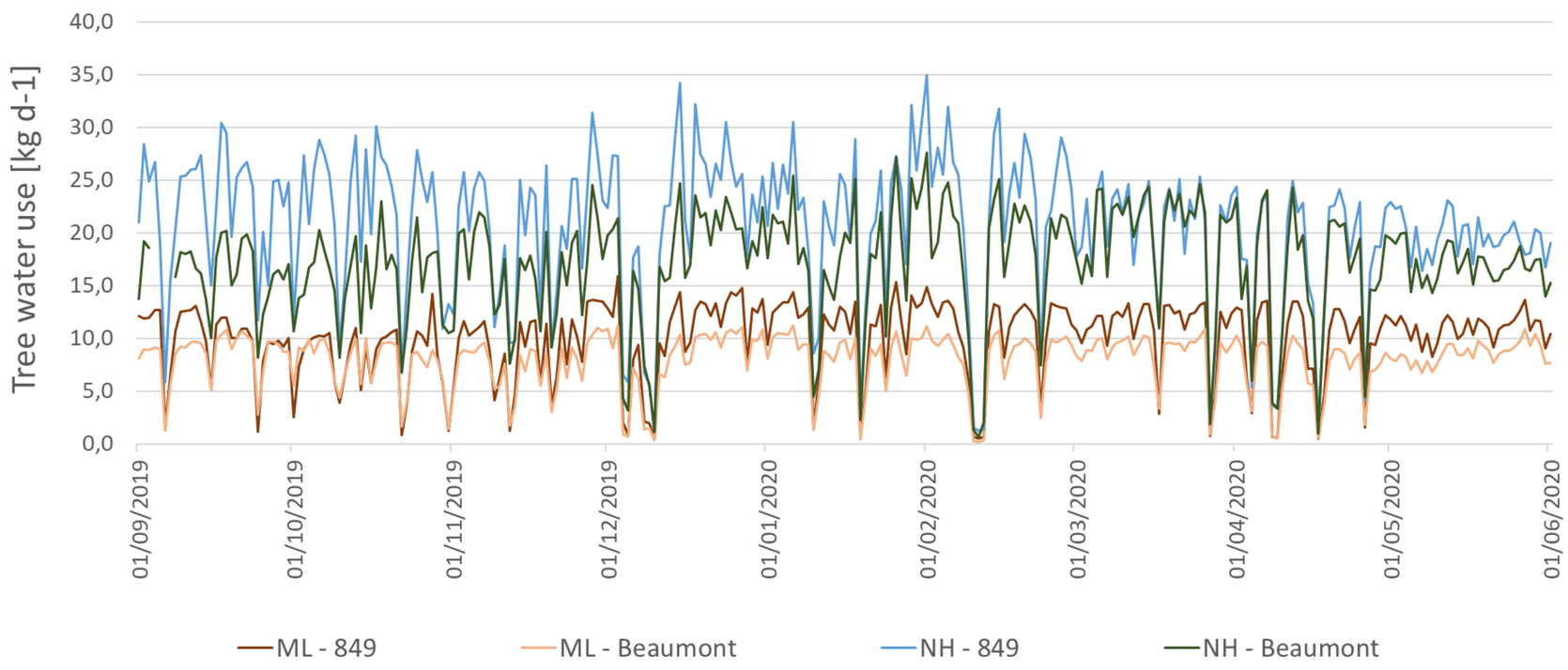
However: **different irrigation intensity** between the two farms (higher at Neuhof)

Detailed measurements on individual trees (15 per orchard) in nested complexity



(a) Weather station at Maclands; (b) datalogger, battery and power boxes; (c) taking soil samples for the analysis of soil properties; (d) installing sap flow sensors; (e) combined soil and tree sensors for detailed monitoring of water relations in macadamia orchards (pictures by Bringhenti, T.)

RESULTS



Daily water use (kg d^{-1}) of macadamia trees growing in two different farms (ML = Maclands, NH = Neuhof) in Limpopo, South Africa, during the period between September 2019 and June 2020. In each farm, the average daily water use of ten trees belonging to two different varieties (HAES 849 and Beaumont, five trees each) were calculated as cumulative daily sap flow (g cm^{-2} d^{-1}) through an estimated sapwood area for each individual tree. Hourly sap flow was measured by using Granier SF-G thermal dissipation sap flow sensors with a scanning frequency of 30 seconds.

KEY MESSAGES

Given the dramatic increase of irrigated macadamia production areas in Limpopo, South Africa, and the increasingly extreme impacts of climate change, in particular the effects of more frequent and severe heat-waves and droughts on macadamia performance and water availability in the region, it is of utmost importance to increase the water use efficiency and climate resilience of macadamia trees, as well as the irrigation efficiency.

Comprehensive field experiments on water dynamics and micro-climate are a prerequisite to increase understanding of the processes and factors affecting tree water use - the focus of this study.

support

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