



Tropentag, September 14-16, 2022, hybrid conference

“Can agroecological farming feed the world?  
Farmers’ and academia’s views”

## Improving water use efficiency for a more sustainable production of *Macadamia* ssp. in South Africa

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### Abstract

Macadamia is currently the most expensive tree nut in the world with a continuously rising demand. South Africa is the world largest producer of macadamia nuts, with orchards increasing by more than 5,000 hectares annually. However, the ongoing expansion of macadamia growing areas comes with environmental downsides, especially in terms of water consumption. Increased use of irrigation water for achieving high nut yields under conditions of periodic droughts and erratic rainfall, puts additional pressure on the limited water resources of South Africa - which are further threatened by climate change. For a more sustainable macadamia production it is paramount to improve water use efficiency.

With this in mind, we aimed to characterise and quantify macadamia tree water use under different environmental conditions (rainy vs. dry season) and considering different cultivars and tree ages.

Data on macadamia transpiration (measured as sap flux density), soil water content and microclimatic parameters was recorded through intensive on-farm experiments over two consecutive years from a total of 20 trees belonging to different cultivars (‘Beaumont’ and ‘HAES 849’) and age classes (intermediate vs. full-bearing). Daily tree water use (calculated as the integration of hourly sap flux density over sapwood area) and transpiration patterns as affected by climate and soil water conditions were compared. The most important drivers of macadamia tree transpiration were then determined using a multiple regression approach.

Our results show that macadamia tree water use significantly varies between cultivars and under different environmental conditions. Full-bearing ‘Beaumont’ and ‘HAES 849’ trees recorded daily water use quantities of 24.5–29.6 and 23.9–36.5 litres d<sup>-1</sup> respectively, between dry and rainy season. Microclimate largely controls macadamia tree transpiration rate: a threshold of ca. 2 kPa of vapour pressure deficit (VPD) was observed beyond which

transpiration was limited regardless of soil water content. This indicates a conservative (isohydric) water use behaviour of macadamia trees, which do not use more water under conditions of high VPD. Therefore, applying large irrigation amounts under such conditions would lead to overirrigation. Hence, there is scope to increase macadamia tree water use efficiency by reducing irrigation amounts, especially during periods of high atmospheric demand.

**Keywords:** Ecophysiology, hydricity, irrigation, sap flux density, South Africa, transpiration, vapour pressure deficit