

EGU2020-4844

<https://doi.org/10.5194/egusphere-egu2020-4844>

EGU General Assembly 2020

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Innovative physiological indicators for drought stress in banana

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Banana is a very important crop in East-Africa, serving as a staple for millions of smallholder farmers. Aside from pests and diseases, lack of water is the major constraint to production. Climate change is expected to aggravate these problems, creating a need for improved resilience and better management practices. A major obstacle to the development and evaluation of such practices is the difficulty to measure drought stress in the field. In this research, we investigate physiological parameters that can provide information on drought stress in banana under field conditions. We evaluate the use of stable carbon isotope ratios ($\delta^{13}\text{C}$) and leaf temperature as indicators for stress, the former ones not well-established for banana. Leaf temperature is known to increase under drought stress due to stomatal closure. The existing methods to measure leaf temperature are however expensive and their use is limited to small greenhouse set-ups. In this research, we employ an infrared thermometer ($\pm 1^\circ\text{C}$) for temperature measurement under field conditions. The experimental set-up consists of a banana field trial with a blocked design (irrigated and rainfed treatments) in the Kilimanjaro region, Tanzania. Leaf samples for isotope analysis were taken from mature plants (mother plants) and the main on-growing sucker (daughter plants) in August 2019, during the dry season. Leaf temperature was monitored throughout the day. Results show significantly higher $\delta^{13}\text{C}$ ratios in rainfed plants, compared to irrigated ones, indicating more drought stress. Within both groups, mother plants have higher $\delta^{13}\text{C}$ ratios than daughter plants. At dawn, leaf temperature was similar for all treatments. During the day, rainfed banana plant leaf temperature increased 7°C more than in their irrigated counterparts. Daughter plants remained cooler than mother plants in both treatments. Leaf temperature and $\delta^{13}\text{C}$ showed a strong correlation. While carbon isotope signatures are a known proxy, our results suggest that leaf temperature is an easily measurable indicator of drought stress as well. The infrared thermometer is cheap, convenient to use in the field and provides in-situ information. Leaf temperature has an enormous potential as a drought stress sensor in banana, as well as in other plants. Our research will further optimize both methods for drought stress evaluation. This will facilitate management comparisons in the future as well as variety screening, eventually contributing to more resilient banana production systems.