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Counteracting the effects of drought on cassava productivity: The role of stable isotopes

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Cassava (Manihot esculenta Crantz) is a tropical root crop and has long been seen as a food security crop, but recently gained more interest by the food industry. To be profitable, the industry needs a year-round supply of fresh cassava roots and therefore contracts farmers to spread the planting times. However, these different planting times require that farmers grow cassava during dry spells, jeopardizing yields. A collaboration between the International Institute of Tropical Agriculture (IITA) and the joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture was established to counteract the effects of drought within the Belgian Government funded CIALCA project (Consortium for Improving Agriculture-based Livelihoods in Central Africa). The main objective of this collaboration is to develop stable isotope techniques for guiding efforts towards increasing water use efficiency (WUE) of cassava-based production systems in Central Africa.

As a first question, it is imperative to know when and what to sample from cassava to extract strategic information on WUE, at plant but also at field level based on stable isotope analysis. Preliminary tests on natural abundance of carbon-13 (^{13}C) and oxygen-18 (^{18}O), indicators for WUE and stomatal conductance respectively, were carried out in the ACAI (African Cassava Agronomy initiative) trials from IITA in Tanzania. These tests showed a large range in ^{13}C (δ^{13} of -21.2 to -26.5‰ and ^{18}O (δ^{18}O of 28.9 to 24.3‰ in cassava leaves, reflecting possible differences between variety and plant growth stages and conditions. Tests in the FAO/IAEA SWMCN greenhouse not only demonstrated a large variability in isotope signature between different plants, but also between leaves of the same plant. Whether to use bulk leaf material or extracted cellulose to reduce variability in isotope signatures is still under investigation. Results will be shown at EGU 2019.

The information extracted via stable isotope analysis will be used to formulate good management practices optimizing WUE. Variety selection, planting time and fertilizer application (potassium) could be determining factors which can be identified based on stable isotope analysis. Therefore, preliminary tests with cassava of different age (2-5 months) planted in pots were conducted. Emphasis was put on the right growing conditions in the greenhouse, including substrate testing. Cuttings survived well and even produced tuberous roots in pots containing sand. Further, a ^{13}C pulse labelling experiment with ^{13}C carbon dioxide was carried out in the FAO/IAEA walk-in growth chamber to compare assimilate translocation between different varieties and management options including water stress and low potassium availability. First results showed that the ^{13}C pulse was taken up by the plants for almost 95%, resulting in a successful labelling of the plants.

The use of stable isotopes to increase water use efficiency in cassava is still in its infancy, but the first promising results show that these isotope techniques will play a major role to cope with drought in cassava-based production systems.