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Potassium and storage root development: focusing on photosynthesis, metabolites and soluble carbohydrates in cassava

John Okoth Omondi[a], Naftali Lazarovitch[a], Shimon Rachmilevitch[a], Titaya Kukew[b], Uri Yermiyahu[c*] and Hagai Yasuor[c*]

[a]French Associates Institute for Agriculture and Biotechnology of Drylands, Ben Gurion University of the Negev, Beersheba, Israel
[b]National Center for Genetic Engineering and Biotechnology, National Science and Technology Development Agency, Khlong Luang, Thailand
[c]Gilat Research Centre, Agricultural Research Organization, Gilat, Israel

Correspondence
*Corresponding authors,
e-mail: uri4@volcani.agri.gov.il,
hagai@volcani.agri.gov.il

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The linkage between K and the development of storage roots in root crops is partially understood, hence this experiment determined some of the mechanisms involved in cassava. The effects of 10, 40, 70, 100, 150 and 200 mg K l^{-1} fertigation on photosynthetic attributes, soluble carbohydrates, starch, metabolites, growth and yield were studied in a greenhouse. Storage root yield, number of storage roots, stomatal conductance and net photosynthesis reached maximum at 150 mg K l^{-1}. However, soluble carbohydrates and starch in the leaves significantly declined with an increasing concentration of K solution, similarly to the trend of glycerol in the leaves. Conversely, malic acid, citric acid and propionic acid gradually increased reaching maximum at 150, 150 and 70 mg K l^{-1} respectively. Combined, these results suggest that sugars were transported from the leaves to a stronger sink – the bulking storage roots. This and the increase of intermediate metabolites of tricarboxylic acid cycle provided the energy required for the bulking process and the development of the storage roots. Although the measured parameters indirectly link K to storage root development, they nonetheless form a basis for studies on direct interactions.

Introduction

Potassium (K) is a macro-nutrient to crops. Improving K nutritional status of a crop enhances its survival under biotic (Hendricks et al. 2015) and abiotic stresses (Cakmak 2005), such as high light intensity, drought, chilling, salinity (Amjad et al. 2014) and iron toxicity (Li et al. 2001). Furthermore, K is required for stomatal conductance, net photosynthesis, phloem loading of photo-assimilates, as signaling molecule (Anschütz et al. 2014), as decentralized energy storage (Gajdanowicz et al. 2011) and booster of enzyme activity (see extensive review of K's importance in crop production by Zorb et al. 2014).

In root and tuber crops, K improves root yields (Hannan et al. 2011). It was observed to increase cassava's root yield by 90.8% compared to no K application (Adekayode and Adeola 2009). Moreover, Ezui et al. (2016) described K as the most limiting nutrient in achieving high root yields. In their study, Alves and Setter (2004) concluded that cassava uses K as a primary osmolyte to osmotically adjust and positively respond to water stress. Despite this, the connection among the mechanisms influenced by K leading to storage root development is only partially understood. Studies on other crops have focused extensively on K's functions without defining a clear pathway linking them to yield increase/decline. For example, the mechanism by which

Abbreviations – DOT, days of treatment; SC, soluble carbohydrates; ST, starch; TCA, tricarboxylic acid cycle; YFEL, youngest fully expanded leaf.