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Strategies of African Indigenous Vegetables to Cope with Phosphorus Deficient Soils

Godfrey Nambafu[1], Enos Onyuka[1], Holger Bessler[1], Nicolai Hoeppner[1], Darius O. Andika[2], Joseph Patrick Gweyi-Onyango[3], Samuel Mwonga[4], Christof Engels[1]

[1] *Humboldt-Universität zu Berlin, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences (ADTI), Germany*

[2] *Jaramogi Oginga Odinga University of Science and Technology, Dept. of Plant, Animal and Food Sciences, Kenya*

[3] *Kenyatta University, Dept. of Agricultural Science and Technology, Kenya*

[4] *Egerton University, Dept. of Crops, Horticulture and Soils, Kenya*

Abstract

Food production in smallholder farming systems of sub-Saharan Africa is often constrained by low soil contents of plant-available phosphorus (P). An option to increase food production is cultivation of species with high P efficiency. Plant strategies to improve growth and P acquisition on low P soils include root foraging strategies to improve spatial soil exploitation, P mining strategies to enhance desorption, solubilisation or mineralisation, and improving internal P utilisation efficiency.

The aim of this study was to measure plant responses to low P availability in soil and to determine if there is variation among African indigenous vegetables (AIV) in their ability to use organic phosphate and sparingly soluble P forms.

Six AIV species (Spider plant *Cleome gynandra*, African nightshade *Solanum scabrum*, Amaranthus *Amaranthus cruentus*, Cowpea *Vigna unguiculata*, African kale *Brassica carinata*, Common kale *Brassica oleracea*) were cultivated under controlled conditions in pots on a low P substrate. The substrate was amended with P using four different forms (highly soluble K_2HPO_4, sparingly soluble $FePO_4$ or phosphate rock, phytate). Measurements included biomass and P concentration in shoots and roots, morphological root traits (root length and diameter, root hair density) and substrate characteristics (pH, content of soluble P) after harvest.

The AIV species significantly differed in morphological root traits and rhizosphere pH, and in the responses of morphological root traits to different P treatments. For example in average of all P levels rhizosphere pH varied from 3.9 in Amaranthus to 6.0 in African kale. All species were able to use P from phytate as effectively for biomass formation as P from K_2HPO_4. The efficiency for utilisation of sparingly soluble P forms (either $FePO_4$ or rock phosphate) was low in African nightshade and Spider plant, and high in Amaranthus and African kale. Cowpea was efficient in utilisation of P from rock phosphate but not from $FePO_4$.

The data indicate large variation among AIV species in root traits relevant for P acquisition and their ability to use soil P from different sparingly soluble P forms. This information may be used for site-specific recommendation of species best adapted to low P soils.

Keywords: P acquisition, phosphate rock, phytate, rhizosphere pH, root morphology

Contact Address: Christof Engels, Humboldt-Universität zu Berlin, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences (ADTI), Berlin, Germany, e-mail: christof.engels@agrar.hu-berlin.de