Tropentag, September 20-22, 2023, hybrid conference

"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Production of a hydroponic nutrient solution from organic residues

Sebastian Heintze[1], Marc Beckett[2], Folkard Asch[1], Jörn Germer[1]

[1] *University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Germany*
[2] *Fraunhofer Society, IGB (Inst. for Interfacial Engineering and Biotechnology), Germany*

Abstract

Hydroponic plant production has great potential as food can be produced without fertile soil, and resource use is more efficient than in traditional agriculture. Nonetheless, hydroponics rely on mineral fertilisers as source for plant nutrients. A possible option to render hydroponic plant production more sustainable is bioponics, where nutrient solutions are derived from nutrient-rich organic residues. However, the nutrient compositions of organic solutions are often unbalanced and, when used in hydroponic plant production, rarely result in yields comparable to those achieved with mineral fertilisers. This study aimed to produce organic solutions rich in either N, P, or K and subsequently mix the solutions to create a nutrient-balanced hydroponic solution.

Blood meal, bone meal, and potato peel were selected as N-, P-, and K-rich residues, respectively. Each residue was mixed with water and digested anaerobically. Bone meal and potato peel for 123 days, blood meal for 54 days. The NH_4^+-rich digestate derived from blood meal was subsequently aerated for 18 days to transform NH_4^+ into NO_3. Samples were regularly taken from each solution and analysed for available nutrients. The three solutions were mixed based on the final NH_4^+-N, NO_3^--N, PO_4^{3-}-P, and K^+ concentrations. The resulting organic nutrient solution contained 58 mg l^{-1} NH_4^+-N, 43 mg l^{-1} NO_3^--N, 50 mg l^{-1} PO_4^{3-}-P, and 247 mg l^{-1} K^+.

The organic solution was tested against a Hoagland solution for lettuce var. Hawking in a deep water culture system for 25 days. In regular intervals the nutrient solution was replaced, plant fresh mass was measured, and samples of the initial and replaced solution were taken. At harvest, plants grown in bioponics had produced 1/3 of the fresh mass of plants grown in Hoagland solution. Poor growth of the plants grown in bioponics was attributed to an unfavourable NH_4^+:NO_3-ratio, changes in nutrient composition, and a high microorganisms load in the organic solution.

The approach of separately digesting organic residues with high N, P, or K concentrations and subsequent mixing did not result in a nutrient solution enabling good plant growth. However, important findings regarding production and utilisation of organic nutrient solutions are presented and discussed.

Keywords: Bioponics, low-tech hydroponics, organic residue reuse, sustainability

Contact Address: Sebastian Heintze, University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Garbenstr. 13, 70599 Stuttgart, Germany, e-mail: sebastian.heintze@uni-hohenheim.de