UNIVERSITY OF HOHENHEIM

Fraunhofer IGB

Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute) Water stress Management (490g)

Production of a Hydroponic Nutrient Solution from Organic Residues

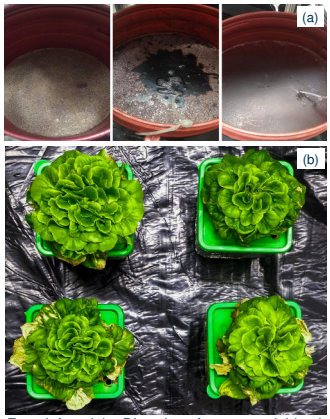
Sebastian Heintze[1], Marc Beckett[2], Jörn Germer[1], Folkard Asch[1]

[1]University of Hohenheim, [2]Fraunhofer IGB

Introduction

The use of organic residues as nutrient source to produce solutions for hydroponic crop production has the potential to reduce the dependence of this cultivation method on mineral fertilizers. Especially in remote regions, the utilization of organic residues for this purpose has great potential. However, nutrient solutions made from organic residues (bioponic solutions), are usually imbalanced in their nutrient composition, resulting in poor plant growth.

The aim of this study was to produce bioponic solutions rich in either nitrogen (N), phosphorus (P) or potassium (K) derived from blood meal, bone meal and potato peels. A mixture of these solutions was tested on lettuce in a hydroponic system.

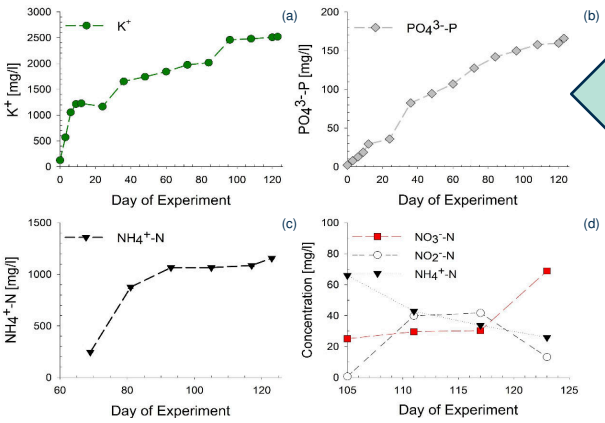


From left to right: Digestion of potato peel, blood meal and bone meal (a). Lettuce plants grown in bioponic solution for 25 days (b).

Conclusions

- Low nitrification rate hindered the production of a balanced bioponic nutrient solution.
- The reduced plant growth in the bioponic solution seemed to be caused not only by an unfavorable nutrient composition, but also by strong biofilm development.
- Nitrate concentration of the bioponic solution must be increased, microorganisms reduced, and phytotoxic compounds potentially present must be identified.

Results and Discussion

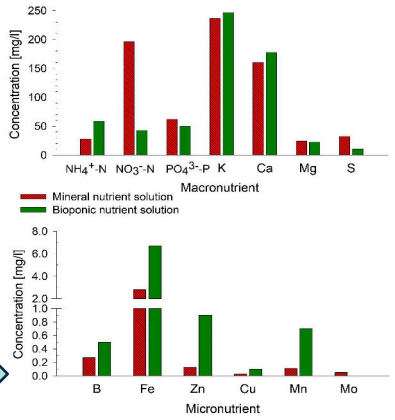


Mineralization of potato peels (a), bone meal (b) and blood meal (c) and the nitrification process of the blood meal solution (d).

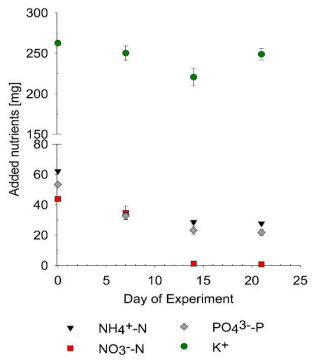
87% of K from potato peels, 20% of P from bone meal and 98% of N from blood meal were mineralized into plant-available K^+, PO_4^{3-}-P, and NH_4^+-N.

Only 5% of NH_4^+-N from blood meal were nitrified into NO_3^--N.

Compared to a mineral solution the mixed bioponic solution had similar PO_4^{3-}, K, Ca, and Mg, but lower NO_3^- and higher NH_4^+ concentrations. Most essential micronutrients were present.



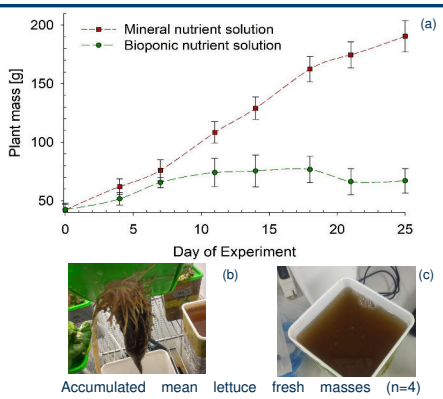
Nutrient concentrations of the bioponic and a Hoagland solution.



Added nutrients by the bioponic solution for one lettuce plant during the hydroponic cultivation trial.

Storage of the bioponic solution reduced NO_3^- and PO_4^{3-} concentrations.

- Newly added bioponic solution contained fewer nutrients than expected
- Most certainly caused by microbial activity and precipitation
- Used heterotrophic nitrifiers: Potentially able to nitrify and denitrify



Accumulated mean lettuce fresh masses (n=4) fertigated with bioponic or Hoagland solution (a). Biofilm on bioponically grown lettuce roots (b), bioponic solution (c).

Poor growth of lettuce plants in bioponic solution.

On harvest day: Only 1/3 of the total fresh mass of plants grown in mineral solution.

- Strong biofilm development → indicating high microorganism load
- Unfavorable NH_4^+:NO_3^- ratio
- Unidentified phytotoxic compounds could be present in the bioponic solution

Materials and Methods

Blood meal, bone meal, and potato peel were selected as N, P, and K-rich organic residues and digested in separate reactors under empirically determined conditions. Bone meal and potato peel were anaerobically digested for 123 days, blood meal for 54 days. 1 l/day of the ammonium-rich blood meal solution was transferred into an inoculated aerated moving bed biofilm reactor for nitrification for 18 days. During the experiment, the solutions were analyzed only for the nutrient of interest. On the last day of the experiment all solutions were analyzed for NH_4^+-N, NO_3^--N, PO_4^{3-}-P, and K^+. The mixed bioponic solution consisted of 621.3 ml NO_3^--, 297.0 P-, and 81.7 ml K-digestate.

Lettuce was grown in a deep water culture system for 24 days in a modified Hoagland solution (HS). After this period four plants were fertigated with bioponic solution, four controls with modified HS for 25 days. The nutrient solution was exchanged twice a week.

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Contact: j.germer@uni-hohenheim.de, sebastian.heintze@uni-hohenheim.de, marc.beckett@igb.fraunhofer.de