

Opportunities for resource efficient water reuse using hydroponic systems (HypoWave)

WavE Online Seminar:
 Innovative Approches to Grow Water Reuse Applications
 28th April 2020
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What is hydroponics?

- Agricultural production in a system without soil
- Irrigation with an appropriate nutrient solution

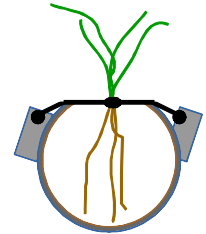


Figure: J. Germer/ UHOH

Objectives of the pilot facility:

- Production of high quality products (→ pollutants and hygiene)
- High resource efficiency (→ water and nutrients)
- High transferability (→ location and scales)
- Wastewater treatment: as much as necessary but as little as possible!
(→ determination of the limits of the system)

Fields of activity of HypoWave

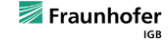


Pilot facility

Governance and integration of stakeholders

Feasibility studies

Impact assessment

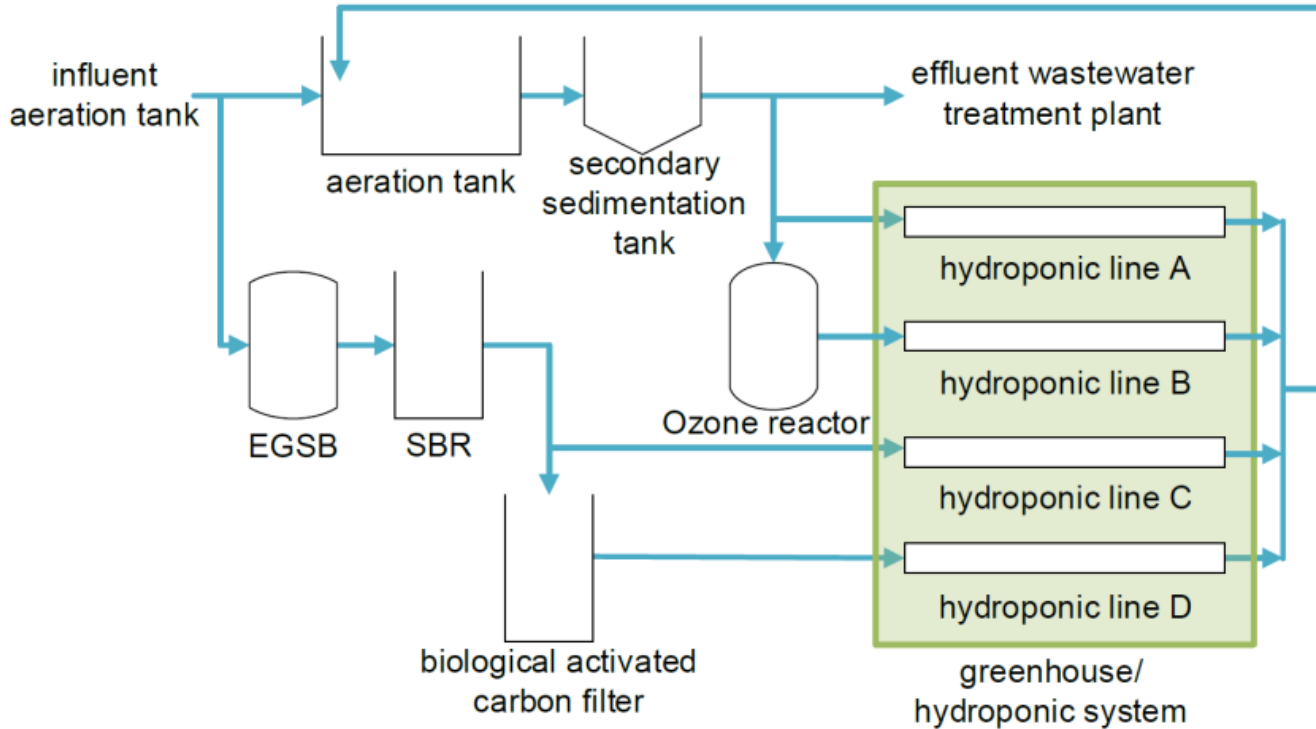


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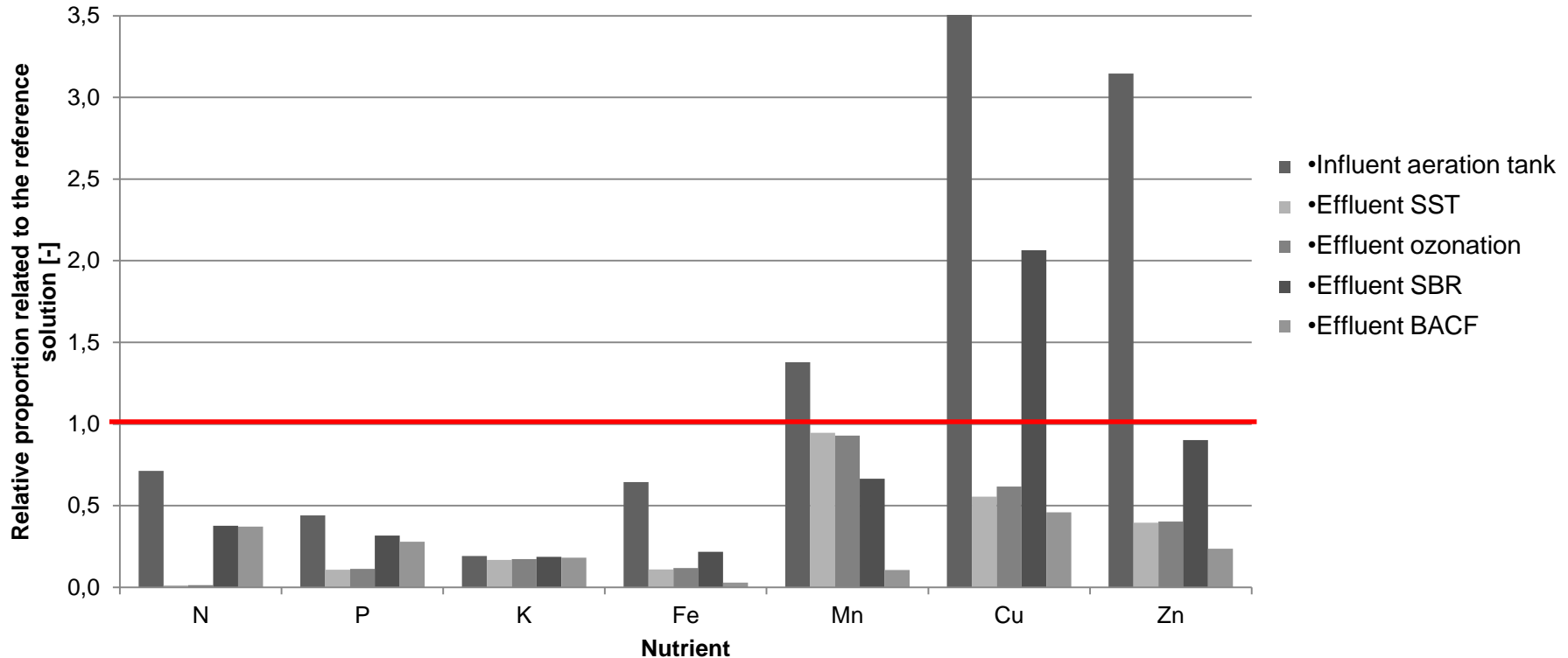


Treatment technologies



Foto: ISWW

Composition of the irrigation water in regard to selected nutrients



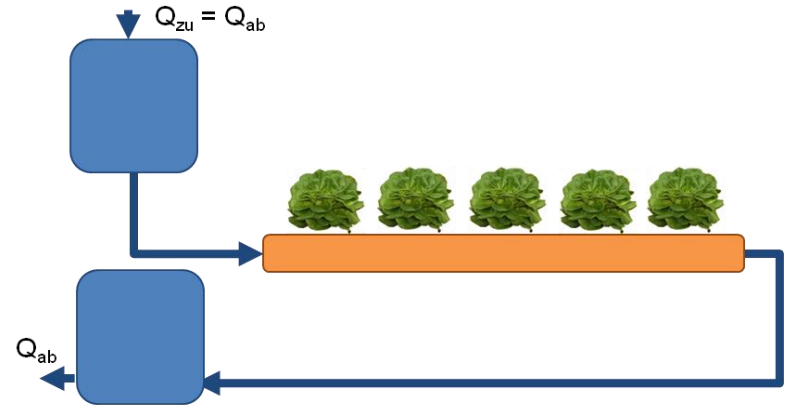
Reference nutrient solution = adapted Hoagland nutrient solution (Concentration = 50%); Results of the analyses (2017-2019)

http://www.hypowave.de/fileadmin/user_upload/Ergebnisse/Vortr%C3%A4ge/2_AlexaBliedung_Herstellung-Bew%C3%A4sserungswasser.pdf (online, 12.10.2020, adapted)

Modes of operation

■ 2017

- ▶ Flow-through system
- ▶ Constant flow
- ▶ Irrigation water:
 - Reference, Effluent SST, Effluent Ozon, Effluent SBR, Effluent BACF



2017: Flow-through system

■ 2018 and 2019

- ▶ Modified circulation system (Feed & Deplete System)
- ▶ $\text{NO}_3\text{-N}$ → criteria for changing water of the barrels
- ▶ Addition of nutrients
- ▶ Irrigation water:
 - Reference, Effluent Ozon, Effluent SBR, Effluent BACF



2018/2019: Feed & Deplete System

Lettuce production



■ Heavy Metals

- ▶ Most values were below the limits of quantification
- ▶ Low concentrations in the shoot (e.g. Co and Hg were clearly below the limit values)

■ Micropollutants

- ▶ Detection of micropollutants in the roots (e.g. Acesulfam, Carbamazepin, Diclofenac)
- ▶ Detection of some micropollutants in the shoot (e.g. Acesulfam, Carbamazepin)
- ▶ Concentration depends on the treatment train

Overview: feasibility studies

- Identification of framework conditions, barriers and drivers for realization of water reuse in hydroponic systems
- Development of concepts for different regions with local stakeholders
- First step for implementation of analyzed innovation



- Despite the unbalanced nutrient composition a good plant growth was possible.
- Addition of some micronutrients was necessary.
- Reduction of quality-reducing parameters (e.g. micropollutants, heavy metals) was required.
- Roots can act as a barrier for micropollutants and heavy metals
- Outlook:

Implementation of a feasibility study as a large scale project

Some recommendations

- . HypoWave-Website (German) www.hypowave.de
 - ▶ Presentations in English
 - http://www.hypowave.de/fileadmin/user_upload/Ergebnisse/Vortr%C3%A4ge/IWA_Reuse_Mohr_2019_final_b.pdf
 - http://www.hypowave.de/fileadmin/user_upload/Ergebnisse/Vortr%C3%A4ge/IWA_HypoWave_Bliedung_V1.pdf
 - http://www.hypowave.de/fileadmin/user_upload/Ergebnisse/Vortr%C3%A4ge/2019-06-19_Operator_models_Bjoern_Ebert_16_9_final_harm.pdf
 - ▶ feasibility studies: results in a brochure
- WavE-Website (German/English) www.bmbf-wave.de/index.php
- Bliedung A., Dockhorn T., Germer J., Mayerl C. & Mohr M. (2020) Experiences of running a hydroponic system in a pilot scale for resource-efficient water reuse. *Journal of Water Reuse & Desalination*, 10(4), 347–362 <https://doi.org/10.2166/wrd.2020.014>
- Winker M., Fischer M., Bliedung A., Bügrow G., Germer J., Mohr M., Nink A., Schmitt B., Wieland A. & Dockhorn T. (2020) Water reuse in hydroponic systems: a realistic future scenario for Germany? Facts and evidence gained during a transdisciplinary research project. *Journal of Water Reuse & Desalination*, 10(4), 363–379. <https://doi.org/10.2166/wrd.2020.020>
- Zimmermann M. & Fischer M. (2020) Impact assessment of water and nutrient reuse in hydroponic systems using Bayesian Belief Networks. *Journal of Water Reuse & Desalination*, 10(4), 431–442. <https://doi.org/10.2166/wrd.2020.026>
- Mohr M., Dockhorn T., Drewes J.E., Karwat S., Lackner S., Lotz B., Nahrstedt A., Nocker A., Schramm E. & Zimmermann M (2020) Assuring water quality along multi-barrier treatment system for agricultural water reuse. *Journal of Water Reuse & Desalination*, 10(4), 332–346. <https://doi.org/10.2166/wrd.2020.039>
- Kreuzig R., Haller-Jans J., Bischoff C., Leppin J., Germer J., Mohr M., Bliedung A. & Dockhorn T. (in press) Reclaimed water driven lettuce cultivation in a hydroponic system: The need of micropollutant removal by advanced wastewater treatment. *Environmental Science and Pollution Research*

Acknowledgement



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HypoWave

Use of hydroponic systems for resource efficient water reuse in agriculture

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Contact data at www.hypowave.de

