Wastewater reuse for sustainable hydroponics: A pilot implementation study

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Introduction

Water scarcity for agriculture is becoming an increasingly urgent challenge, particularly in view of growing global food demands and climate change resulting in changes in precipitation patterns and more frequent droughts. To mitigate these impacts, re-using wastewater for agricultural irrigation has emerged as a promising approach. In pursuit of sustainable water use, this study was conducted to evaluate hydroponic plant growth in reclaimed waste water and to explore the plants' potential to purify wastewater.

Conclusions

- Wastewater reuse allows hydroponic tomato production and thus paves the way for sustainable water management.
- The study underscores the natural capacity of plants to purify reclaimed wastewater during cultivation for advanced wastewater purification prior to environmental discharge.

Results and Discussion

Nutrients & Wastewater purification

Nutrient concentrations in conventional hydroponics (CON) and wastewater-supplied hydroponics (RWW) (mg/L)

Nutrient	CON	RWW
NO_3	144.2	1.9
NH_4	7.0	21.1

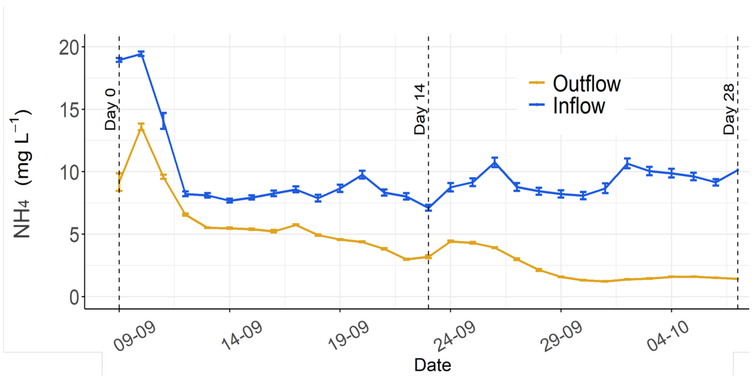


Figure 1. Average daily variation of NH_4, EC, and pH in reclaimed water (RWW) over the experimental period, with harvesting dates marked at Day 0, Day 14, and Day 28.

- RWW contained high proportion of NH_4 than in conventional water
- NH_4 in the hydroponic outflow was reduced compared with the inflow

➢ **Plant growth removed contaminant in the wastewater through nutrient uptake**

Nutrient uptake

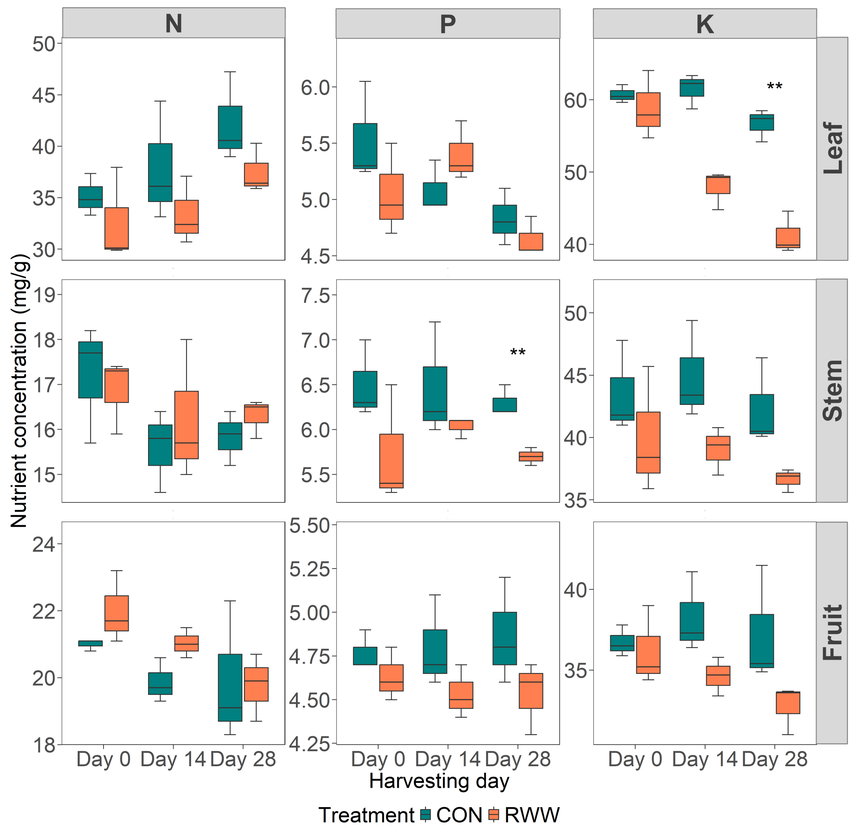


Figure 2. Nutrient uptake in plant shoot under conventional water (CON) and reclaimed wastewater (RWW) across harvesting time. Asterisks indicate statistically significant differences between treatments within the same plant part ($p < 0.01$).

- Under RWW treatment, nutrient uptake decreased over time
- Significant differences in P and K uptake were observed in stems and leaves between RWW and CON treatments

➢ **Decreased nutrient uptake of plants in RWW treatment can negatively affect plant growth**

Biomass

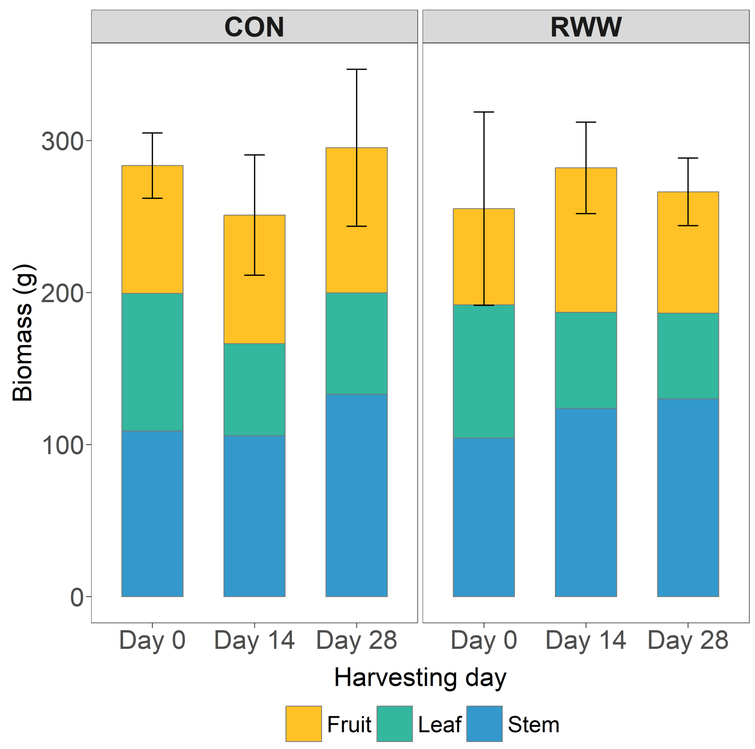
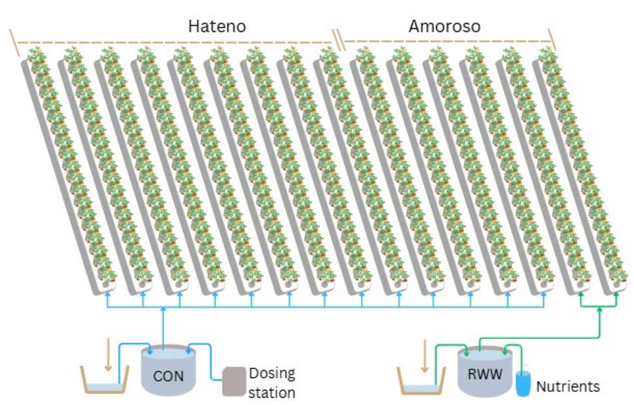


Figure 3. Shoot biomass of plants irrigated conventional water (CON) and with reclaimed wastewater (RWW), measured at Day 0 (start of RWW treatment), Day 14 and Day 28 of the experimental period.

- Plants treated with RWW exhibited similar biomass to those grown with CON water

➢ **Despite nutrient imbalances, plant growth was not affected by RWW fertigation**

Materials and Methods

The pilot was conducted in a commercial hydroponics greenhouse in Weissenberge, Germany. Two tomato varieties were cultivated: Hateno and Amoroso. The hydroponic system used rockwool as a substrate, with each plant connected to a dripper for irrigation.

Two fertigation systems were installed: a conventional system (CON), which used a nutrient solution (INTEGAR_Institut für Technologien im Gartenbau GmbH, Dresden, Germany) prepared with rainwater, and a reclaimed wastewater (RWW) system, which used nutrient solution based on reclaimed wastewater. In the RWW system, the nutrient solution was managed according the "feed&deplete" approach (Germer et al., 2023). The CON system applied for all Hateno plants and 4 rows of Amoroso from when the plants transplanted in the greenhouse, while the remaining 2 Amoroso rows were irrigated with reclaimed wastewater starting later (on 09 September 2024), during the fruiting stage.