WASTEWATER TREATMENT FROM SOILLESS TOMATO CULTIVATION - THE INFLUENCE OF HYDRAULIC RETENTION TIME

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Introduction

Cultivation of plants on an inert substrate, such as mineral wool or coconut fiber, entails excess use of the nutrient medium compared to the actual demand of plants for nutrients and water. This is to provide the plants with the right amount of minerals, prevent the substrate from salinizing, and thus to avoid plant growth suppression or inhibition. In the soilless cultivation of tomatoes in greenhouses, the volume of overflow ranges from 25 to 50% of their water demand (1). Consequently, from 4.5 to 12.6 L of highly concentrated wastewater drains daily from one square meter(2).

The use of closed drainage water circuits can reduce the consumption of both freshwater and minerals used to prepare the nutrient medium. At the same time, it can reduce production costs and increase the competitiveness of this type of cultivation compared to open systems or traditional field crops. However, the reuse of drainage waters has specific bottlenecks. Uneven uptake of nutrients by plants disturbs their ratios and impairs solution re-balancing. At the same time, the nutrient medium must be free of pathogens that can reduce crop yields or destroy entire crops. For these reasons, direct recirculation of the nutrient medium is difficult in practice.

Due to greenhouse wastewater composition (high concentrations of nitrogen and phosphorus compounds, low concentrations of organic compounds), its treatment by means of conventional biological methods based on activated sludge is extremely difficult. For this reason, alternative treatment methods are sought (3).

Experimental

The experiment was conducted in reactors included in the laboratory installation for drainage treatment operating based on biomass attached to the filling (biofilm). The biological treatment processes were supported by an external carbon source. The C:N ratio used was 2, which provided suitable conditions for the development of heterotrophic microorganisms. 4 hydraulic retention times were tested: 24 (V1), 48 (V2), 72 (V3), 96h (V4). The study was conducted with wastewater derived from a facility for soilless tomato cultivation in greenhouses with mineral wool used as a substrate.

Figure 1 Full-technical scale soilless tomato cultivation in North-Eastern Poland

Drainage water from soilless tomato cultivation

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Organic substrate C/N=2.0

V1 HRT 24h

V2 HRT 48h

V3 HRT 72h

V4 HRT 96h

Installation for wastewater treatment from soilless tomato cultivation

Treated drainage water from soilless tomato cultivation

Figure 2 The scheme of experiment

Results and discussion

The conducted research showed high efficiency of the use of the organic substrate and denitrification. The highest nitrogen removal efficiency was recorded for HRT = 96h and amounted to 97.8%. The efficiency of using the organic substrate was 89.2%. This corresponded to the concentration of total nitrogen and total organic carbon in the treated wastewater of 14.2 mgN/L and 121.4 mgC/L, respectively. Due to the organic acid substrate used, the pH ranged from 2.8 to 8.7. The electrolytic conductivity ranged from 8.6 to 4.8 mS/cm^{-1}, which indicates a significant removal of dissolved impurities.

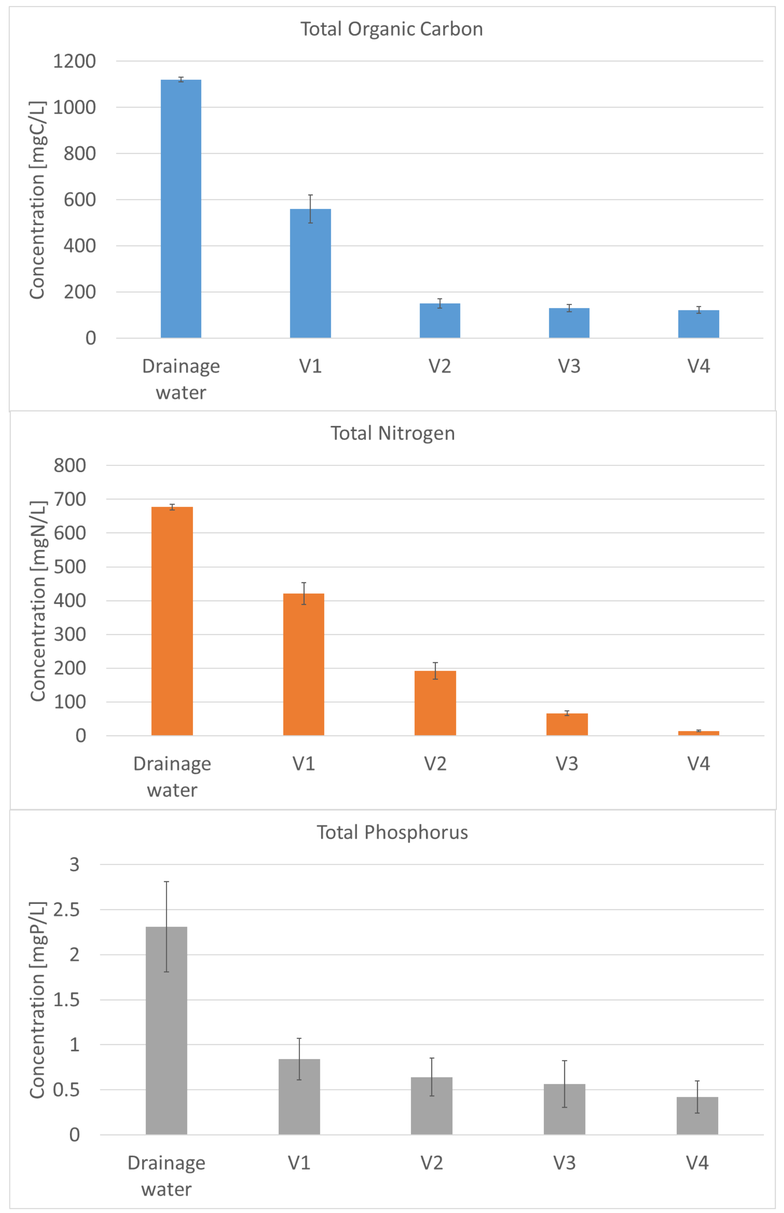

Figure 3 Changes in the concentration of total organic carbon, total nitrogen and total phosphorus

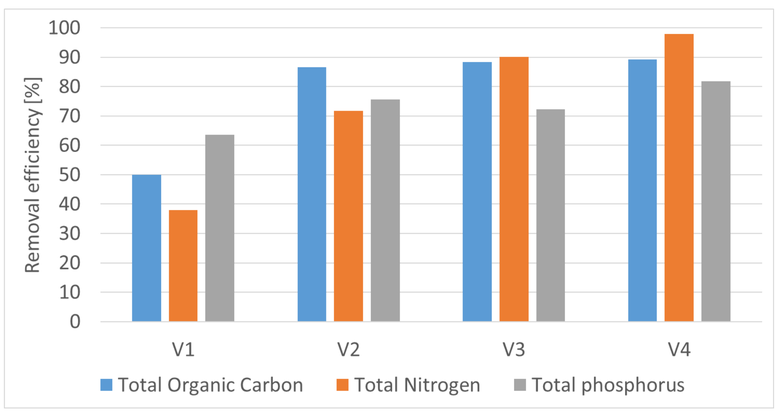

Figure 4 The effectiveness of organic carbon, total nitrogen and total phosphorus removal

Conclusions

The conducted research allows to conclude that wastewater from soilless cultivation of tomatoes can be subjected to biological treatment processes supported by an external source of carbon. The C:N=2.0 ratio ensures high efficiency of denitrification, but it requires a long retention time.

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