Effect of acetate feeding method on the effectiveness of bio-treatment of drainage from soilless tomato cultivation by a biofilm

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Introduction

Soilless tomato cultivation under cover ensures the supply of fresh products with stable parameters all year round. Plants need water and approximately 13 micro- and macro-elements in appropriate ratios to grow. A by-product of fertigation is the overflow (drainage), the volume and composition of which change under the influence of weather conditions and plant growth stages. The main change relates to ratios of individual elements. Drainage contains root secretions, including phytohormones, but may also contain pathogens and thus needs to be purified before being discharged to the natural environment or re-used. The bio-treatment of drainage requires increasing the C:N ratio by feeding an organic substrate. However, not only substrate feeding itself but also the feeding method affect technological parameters of reactor operation. The present study aimed to establish the optimal feeding method of a commonly deployed external carbon source to aid bio-treatment processes.

Experimental

The experiment was conducted in reactors included in the laboratory installation for drainage treatment operating based on biomass attached to the filling (biofilm). Sodium acetate was used as an external carbon source at C:N=1.5, which ensured appropriate conditions for the development of heterotrophic microorganisms. Hydraulic retention time of drainage in the reactor was 24 h, whereas the single volume of treated drainage was 2L. Three variants of feeding the organic substrate to the reactor were tested in the experiment:

V1 – 100% of the organic substrate dose fed at the beginning of the cycle with a new load of drainage to be treated;

V2 – 50% of the organic substrate dose fed at the beginning of the cycle with a new load of drainage to be treated and the remaining 50% fed after 12 h of the cycle;

V3 – organic substrate evenly fed to the reactor throughout the cycle.

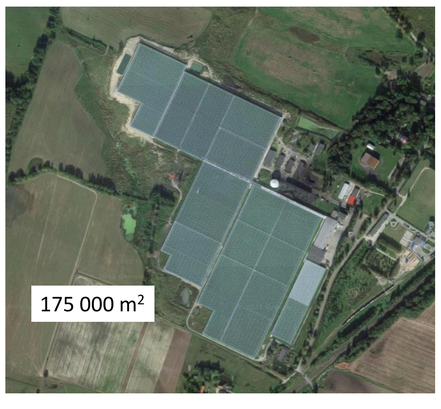

Figure 1 Full-technical scale soilless tomato cultivation in North-Eastern Poland (Europe) https://www.google.pl/maps

Drainage water from soilless tomato cultivation

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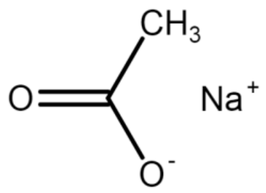

External sources carbon-sodium acetate

V1

HRT 24h; 100% organic substrate supplied at cycle start

V2

HRT 24h; 50% organic substrate supplied at cycle start, another 50% after 12h

V3

HRT 24h; organic substrate evenly fed to the reactor throughout the cycle

Treated drainage water from soilless tomato cultivation

Precipitate rich in phosphorus and potassium

Figure 2 The scheme of experiment

Results and discussion

The one-time feeding of the substrate (V1) causes the concentration of organic compounds to firstly rapidly peak and then to decrease in the subsequent hours of the cycle. This allows the organic matter to reach deeper biofilm layers and creates more reductive conditions in the reactor. The even organic substrate feeding method (V3) makes it available only for the surface biofilm layer and, as such, may inhibit the course of heterotrophic processes. The quality of drainage, in terms of concentrations of organic compounds, nitrogen and phosphorus, enabled its discharge to the natural environment in compliance with regulations in force in Poland.

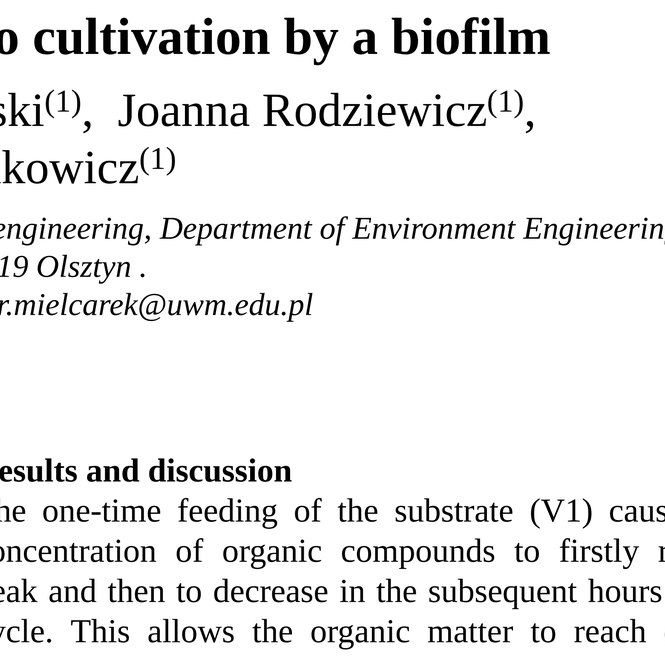

Figure 3 Changes in the concentration of total nitrogen and total phosphorus

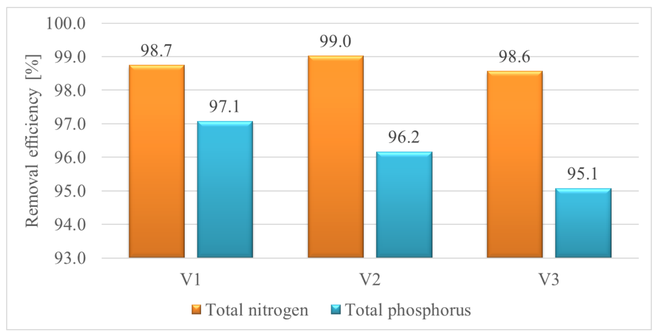

Figure 4 The effectiveness of total nitrogen and total phosphorus removal in EBR

Conclusions

In the case of an organic substrate having a neutral pH and being easily-biodegradable, the method of its feeding had no significant effect on the effectiveness of denitrification and dephosphatation of drainage from soilless tomato cultivation. Significant differences were noted in the volume and structure of biomass on the filling.

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