The Use of Passive Bioreactors to Simultaneously Remove NO_3, SO_4 and Plant Pathogens from Organic Greenhouse Effluent.

N. Gruyer[1], M. Dorais[1]*, B. Alsanius[2] and G. J. Zagury[3]
1. Agriculture and Agri-Food Canada, Horticultural Research Centre, Laval University, Quebec, QC.
2. Swedish University of Agricultural Sciences, Department of Horticulture, Microbial Horticulture Laboratory, P.O. Box 103, SE-230 53, Alnarp, Sweden.
3. Department of Civil, Geological & Mining Engineering, École Polytechnique de Montréal, Montreal, QC.
* martine.dorais@agr.gc.ca

Background: Runoff of greenhouse nutrients creates environmental burdens such as eutrophication when the wastewater is not recycled. When the crop effluent is recycled, selective nutrient accumulation and consequently imbalances of ions such as sulfate (SO_4^{2-}) might lead to physiological plant disorder if the recycled nutrient solution is not partly replaced. Although recycling growing systems offer several advantages from an environmental standpoint, the risk of pathogen dissemination is also a major concern for growers. Passive bioreactors have been shown to be a low-cost biological alternative for treating agricultural or industrial wastewaters.

Project Overview: Therefore, the objective of this study was to evaluate the use of passive bioreactors to reduce the nutrient load (NO_3^- and SO_4^{2-}) and water-borne plant pathogens (*P. ultimum* and *F. oxysporum*) from greenhouse effluents. Sterilized and non-sterilized passive bioreactors (3 L) filled with a mixture of organic carbon material were used in 3 replicates. Prior the experimental period, bioreactors were saturated with sterilized Postgate B medium to promote the sulphate reducing bacteria. After a start-up period of 2-5 weeks, bioreactor units received during 15 weeks a reconstituted effluent including 500 mg L^{-1} SO_4^{2-} with or without 300 mg L^{-1} NO_3^-, and were inoculated 3 times with *P. ultimun* and *F. oxysporum* (10^6 CFU mL^{-1}). The efficacies to remove water-borne plant pathogens (99.9%) and nitrate (99%) were high for sterilized and non-sterilized bioreactors. During the first 6 weeks of water treatment, percentage of SO_4^{2-} removal was more important in non-sterilized bioreactors compared to sterilized bioreactors, indicating that SO_4^{2-} reduction was mainly due to its biological activity. In the absence of nitrate, percentage of SO_4^{2-} removal was high (86% to 91%) and drastically declined after NO_3^- addition. This NO_3^- effect can be explained by the fact that in anaerobic sediments, denitrification is the most energetically favorable form of respiration as sulfate-reduction yields less energy and hence tends to occur when NO_3^- is not available. The removal of SO_4^{2-} would thus be expected to occur sequentially after the depletion of NO_3^- as observed in the non-sterilized bioreactors at weeks 13 and 14 (3 to 4 weeks after NO_3^- addition).

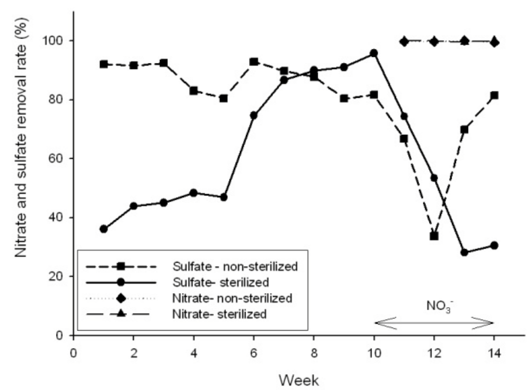

Figure 1 Evolution of the percentage of sulfate and nitrate removal of non-sterilized and sterilized bioreactors. Nitrate (300 mg L^{-1}) was added to affluent after week 9 until week 14. Date are means of n=3. Significant differences ($P<0.05$) were observed between the percentage of SO_4^{2-} removal of non-sterilized

Conclusions: This study shows that bioreactors are effective to treat greenhouse effluent. In the same times, bioreactors reduce sulfate, nitrate and water-borne plant pathogens.

Acknowledgments: This research was funded through Canada's Organic Science Cluster, which in turn was funded by the Canadian Agri-Science Clusters Initiative of Agriculture and Agri-Food Canada's Growing Forward Policy Framework and its industry partner, Les Serres Nouvelles Cultures. We are grateful to Claudine Ménard, Édith Tousignant and Réjean Bacon for their contribution to this project.