Enrichment of Artificial Wetlands with Biochar to Improve their Efficiency and Reduce N_2O Emission.

M. Bolduc[1]*, M. Dorais[1*], V. Gravel[1], P. Rochette[3] and H. Antoun[2]
1. Agriculture and Agri-Food Canada, Horticultural Research Centre, Laval University, Quebec, QC.
2. Horticulture Research Centre, Dept. of Soil and Agri-Food Engineering, Laval University, Québec, QC.
3. Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Ste-Foy, QC.
* martine.dorais@agr.gc.ca

Background:

Greenhouse effluents, whether from organic or conventional systems, are usually highly charged with nutrients. During one year of growing tomato plants we observed that effluent from an organic crop grown in containers greatly varied according to the fertilization management and time of sampling but could reach 400 ppm N, 111 ppm K, 26 ppm P, 90 ppm Ca, 31 ppm Mg, 743 ppm SO_4, 4 ppm Cl and 375 ppm Na. In production systems where recirculation is not used, volume of drained solution rejected in groundwater can cause significant environmental burdens. Recently, we have shown that artificial wetlands can constitute an interesting alternative for growers by reducing the N (58-80%), P (65-100%), SO_4 (10-98%), Cl (30-87%) and Na (44-54%) content of the greenhouse wastewater. However, we observed that emission of N_2O from horizontal subsurface flow wetlands can be much higher than soil amended with cow or pig manure. Adding biomass-derived black carbon (biochar) to the filtering medium in constructed wetlands may be an option to improve nutrient removal.

Project Overview:

The objective of this study was to evaluate the efficiency of biochar as a filtering medium to reduce the charge in nutrients (N, P, SO_4 and Na) of organic greenhouse effluents and GHG emission (N_2O). Thirty-six wetland units (0.88 m^3 each) implanted with *Typha latifolia* were built in order to compare 6 treatments (2x3) in 6 replicates: Gravel or coarse sand without (control) or with 15% Biochar (as a layer filter of 20 cm wide x 71 cm deep) or incorporated to the filling media; 15% v/v; Balsam fir + white and black spruces; pH 7.1, EC 0.38). The following parameters were measured: EC, pH, pollutant load (anions and cations), COD, TOC, greenhouse gas emission (CO_2, N_2O and CH_4), total microbial activity, denitrifying microorganisms, sulphate reducing bacteria as well as macrophyte growth. Preliminary results showed that microbial activities as well as the efficiency to reduce pollutants were higher in wetlands filled with gravel compared to sand. For elements of environmental interest such as nitrate and phosphate, all types of wetlands have reduced their amount by almost 100% after 2 months (Figure 1). N_2O and CO_2 flux were almost nil and did not vary according to the wetland filling material or biochar treatments at the low nitrogen content of the organic effluent.

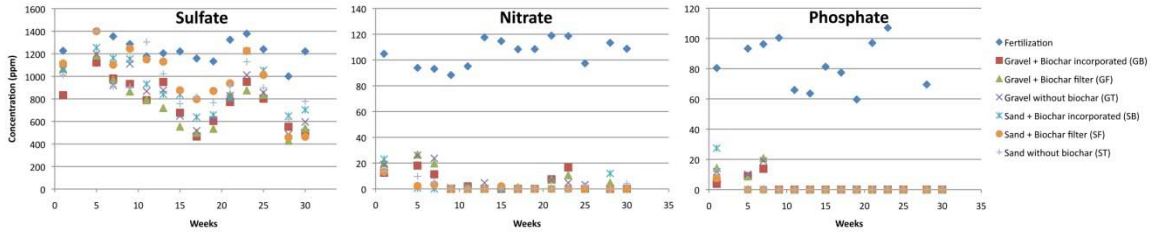

Figure 1 Evolution of the sulfate, nitrate and phosphate concentrations measured in treated organic greenhouse effluents during 30 weeks compared to the influent (fertilization; runoff solution).

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 Normand Bertrand, Claudine Ménard, Édith Tousignant and Réjean Bacon for their contribution to this project.