Impact of continuous application of papermill and liming materials on soil microbial community structure and biomass C, N and P

Dalel ABDI1,2, Noura ZIADI1*, Yichao SHI1, Roger LALANDE1, Bernard GAGNON1 and Léon-Étienne PARENT2

1Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Québec, QC, Canada.
2Department of Soils and Agri-Food Engineering, Université Laval, Québec, QC, Canada.

*noura.ziadi@agr.gc.ca

Introduction

- Soil microorganisms play an important role in the cycling of nutrients by acting as a sink or a source of carbon, nitrogen and phosphorus.
- Microbial biota of soil receiving industrial by-products such as papermill biosolids (PB) and liming materials can be positively affected, but little is known about PB effects on the microbial community structure and biomass carbon (MBC), nitrogen (MBN) and phosphorus (MBP).

Objective

- Evaluate the residual effect of nine annual applications of PB and different liming materials on soil microbial community structure and MBC, MBN and MBP.

Materials and Methods

- A field study was conducted from 2000 to 2008 (9-yrs) at Yamachiche, QC, Canada, on a loamy soil (Gleysol) cropped to grain corn, dry bean and soybean.
- Soil pH (0 – 15 cm) = 6.2.
- Treatments, in a RCB design with 4 replicates, were surface applied annually to the same plots at post-seeding.
- Treatments consisted of:
  - 4 PB rates: 0, 30, 60, and 90 Mg wet ha⁻¹.
  - 3 liming by-products: calcitic lime (CL), lime mud (LM), and wood ash (WA), each at 3 Mg wet ha⁻¹ with 30 Mg wet PB ha⁻¹.
  - Mineral N fertilization (MIN): 120 kg N ha⁻¹ in grain corn and 20 kg N ha⁻¹ in leguminous.
- Three years after treatments application ending (fall 2011), soils were sampled (0 – 15 cm and 15 – 30 cm) after harvest, and analyzed for the phospholipids fatty acids (PLFA) (Lalande et al., 2005) and their contents in MBC, MBN (Voroney et al., 1993) and MBP (Brookes et al., 1982).
- PLFA was analyzed with SAS software (SAS Institute, Inc. 2004) using principal component analysis (PCA).
- ANOVA was performed with the GLM procedure (SAS Institute, Inc. 2004) to compare the treatment effects on MBC, MBN and MBP.

Results and Discussion

- Liming by-products supplemented with 30 Mg PB ha⁻¹ were significantly separated from PB applied alone in both soil layers (Fig. 1a,c).
- Mineral N fertilization tended to cluster with control (0 PB) in the 0-15 cm layer (Fig. 1a) and with the liming by-products in the 15-30 cm layer (Fig. 1c).
- PB application was mostly driven by bacteria and fungi (C18:2w6,9), whereas liming materials were primarily driven by arbuscular mycorrhizal fungi (C16:1w5) in both soil layers (Fig. 1b,d).

Conclusions

- The community structure (bacteria, fungi, arbuscular mycorrhizal fungi) was specific to treatment.
- After three years of material application ending, soil microorganisms immobilize C, N, and P in their biomasses with increasing rates of added PB.
- Nine annual application of PB alone or combined with liming materials resulted in an improvement of soil MBC, MBN and MBP which can be sustained for years for this site.

References