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Soil microbial biomass, activity, and community structure as affected by mineral P fertilization in two grassland soils

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Introduction

- Soil microbiota is a major driver of soil formation, nutrient cycling, and organic matter turnover.
- Reports on how phosphorus (P) fertilization affect microbial properties in arable soils are contradictory. Zhong and Cai (2007) report that mineral P fertilizer increased microbial biomass and diversity, while others found no significant effect on the composition of soil microbial communities (Hamel et al. 2006; Shi et al. 2012, 2013).
- Soil microorganisms response to mineral P fertilization in grasslands is poorly understood.

Objective

- To assess the effect of mineral P fertilization on soil microbial biomass, activity, and community structure in timothy-based grasslands of eastern Canada.

Materials and Methods

Site description

- Two sites in timothy (*Phleum pratense* L.) were seeded in 2009.
  ---- a Kamouraska clay at Lévis;
  ---- a Labarre clay loam at Normandin.

Experimental design

- Three P rates (0, 20, and 40 kg P ha^{-1}; P0, P20, P40, respectively) were applied in the spring of each year starting in 2010 with three replications.

Soil sampling and measurements

- In 2013, soils were sampled to a depth of 10 cm in June, Aug.–Sept., and Oct. at both sites.
- Soil microbial biomass C (SMB-C), N (SMB-N) and P (SMB-P), dehydrogenase and alkaline phosphamonoesterase (Alk-PO_4), and phospholipids fatty acids (PLFA) were analyzed as in Shi et al. (2012).
- Soil chemical properties (pH, total C and N, Mehlich-3 P) were determined (*Table 1*).

Statistical analysis

- Data were analyzed with the MIXED procedure of SAS.
- The relative abundance of PLFA was analyzed using principal component analysis (PCA) and MANOVA.

Results and discussion

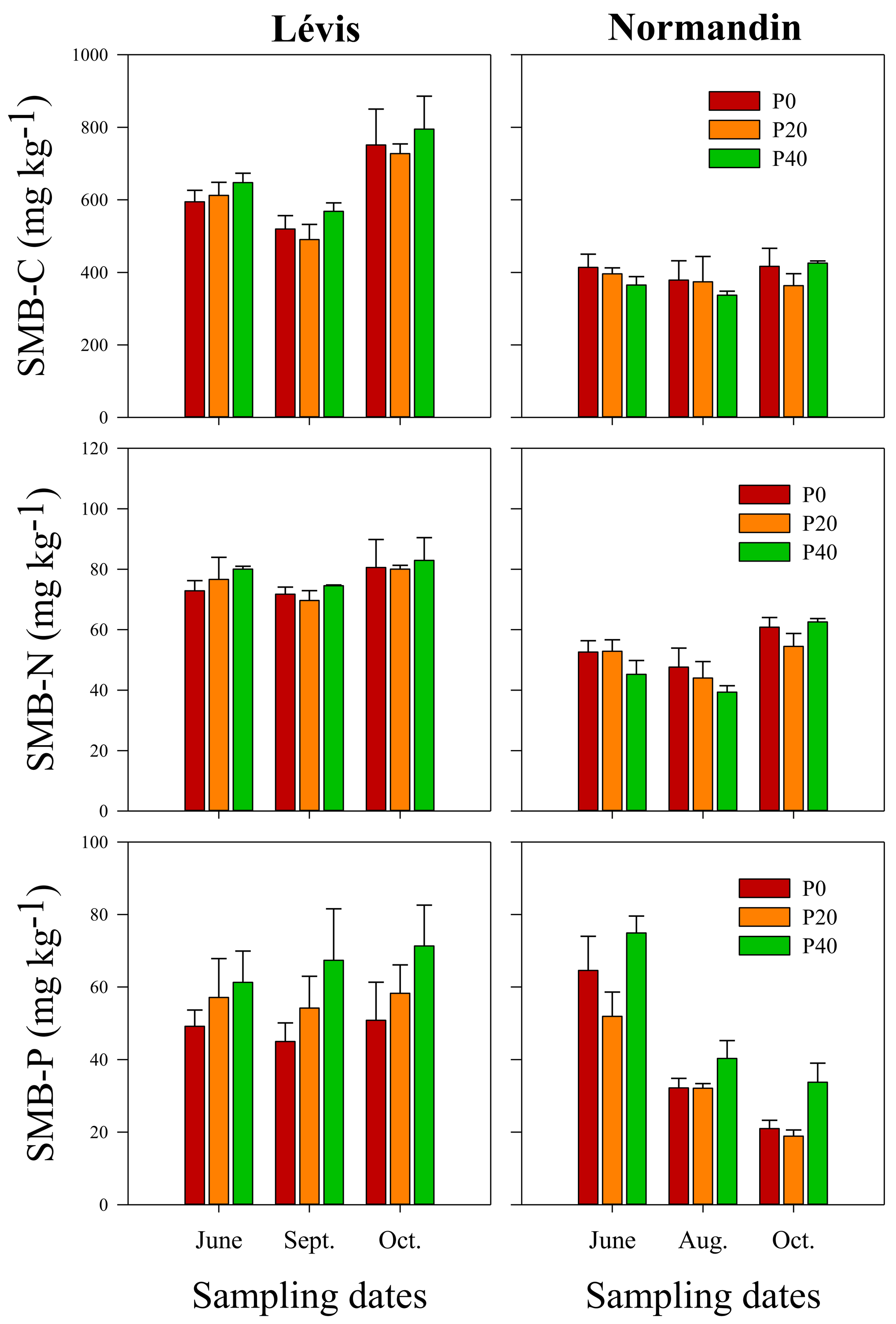

Figure 1. Effect of P fertilization on soil microbial biomass C (SMB-C), N (SMB-N), and P (SMB-P).

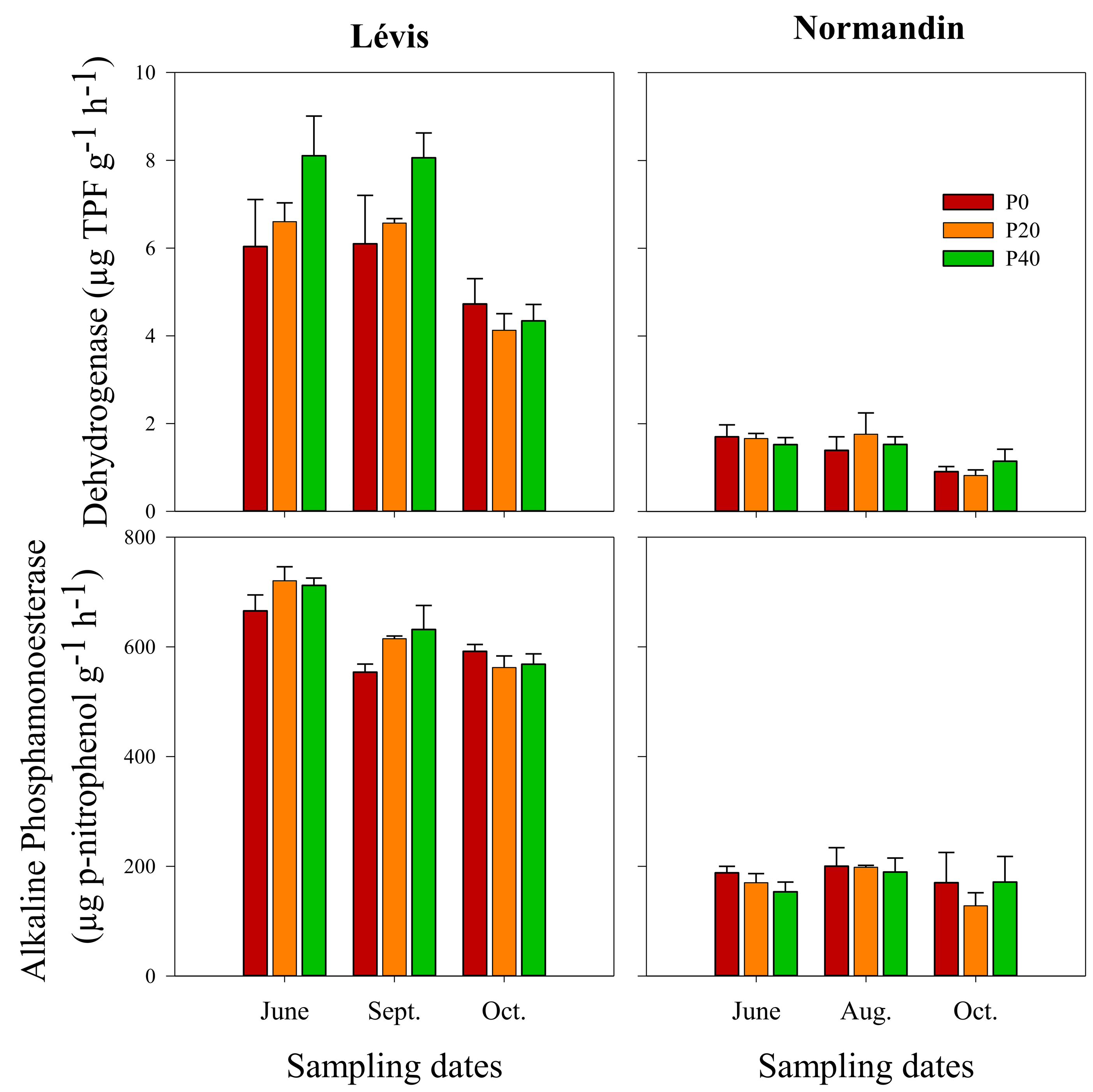

Figure 2. Effect of P fertilization on soil dehydrogenase and alkaline phosphamonoesterase activity.

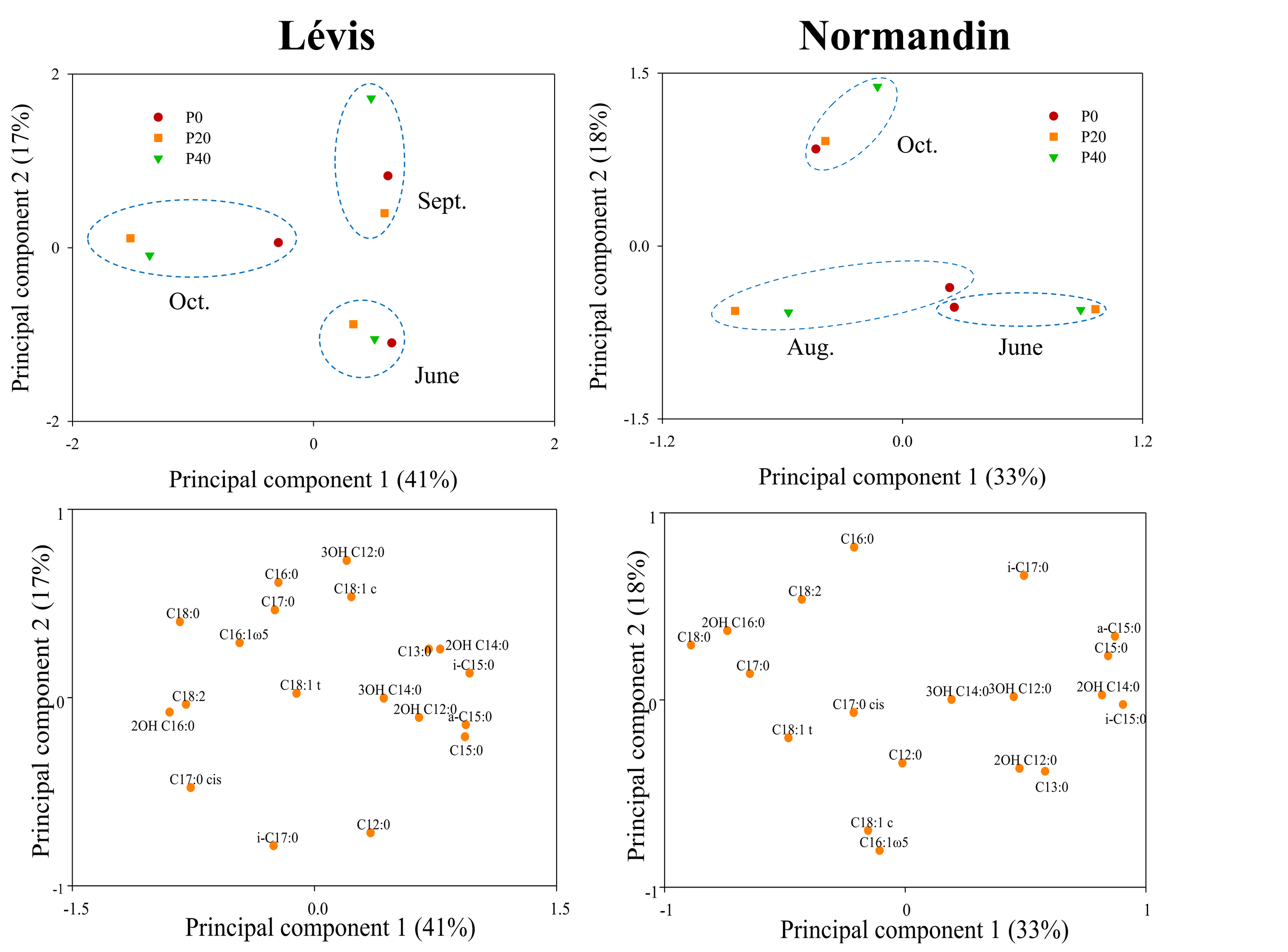

Figure 3. Ordination plots of the microbial community structure (based on phospholipids fatty acids) as determined by PCA.

- P fertilization had no significant effect on SMB-C and SMB-N (*Fig. 1*), and on dehydrogenase and Alk-PO_4 at both sites (*Fig. 2*).
- SMB-P was greater with P40 than with P0 and P20 at Normandin, but was not affected by P fertilization at Lévis (*Fig. 1*). The same trend was also observed in soil Mehlich-3 P (*Table 1*).
- The soil microbial community structure was significantly influenced by sampling dates, but not affected by P fertilization (*Fig. 3*), as previously reported by Shi et al. (2013) in a long-term corn-soybean rotation.

Table 1. Effect of P fertilization on soil pH, total C and N, and Mehlich-3 P.

Treatments	Lévis				Normandin			
	pH	Total C ----g kg^{-1}----	Total N	Mehlich-3 P mg kg^{-1}	pH	Total C ----g kg^{-1}----	Total N	Mehlich-3 P mg kg^{-1}
P0	6.0a	44.1a	3.5a	11.2a	5.1a	23.3a	1.9a	16.8b
P20	6.0a	44.5a	3.6a	19.2a	5.2a	23.2a	1.8a	28.8b
P40	6.0a	44.0a	3.4a	28.8a	5.2a	22.6a	1.8a	52.5a

*Means followed by different letters in each column are significant different ($\alpha < 0.05$).

Conclusion

One year of data suggests that four years of P fertilization has limited effects on the composition and function of the soil microbial community of timothy-based grasslands in eastern Canada.

References

***Hamel et al.* 2006**. Soil Biol. Biochem. 38:2104–2116. ***Shi et al.* 2012**. Appl. Soil Ecol. 62:14–23. ***Shi et al.* 2013**. Biol. Fertil. Soils. 49: 803–818. ***Zhong and Cai.* 2007**. Appl. Soil Ecol. 36: 84–91.

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