Phosphorus in the Coarse Soil Fraction is Related to Organic P Mineralization Measured by Isotopic Dilution

Nicolas Wyngaard[1,2], Miguel Cabrera[2], and Else Bünemann[3] (*niwyngaa@uga.edu)*
[1]UNMdP (Argentina), [2]University of Georgia (United States), [3]ETH Zurich (Switzerland)

Measuring or estimating organic P (P_o) mineralization would help to better quantify plant available P

This would potentially improve P fertilizer recommendations, reducing the economic and environmental impact of fertilization

Can we measure P mineralization?

Yes, by the isotopic dilution method, but it is:
Expensive **Complex** **Hazardous**

Can we estimate P mineralization?

Objective

Materials and Methods

- Soil samples (0 to 20 cm) from Delaware , Maryland, and Iowa never fertilized (Control) or fertilized (>10 years) with mineral P or poultry litter.
- Quantification of gross P_o mineralization rate measured by the isotopic dilution method (Oehl et al., 2001) at 1, 6 and 13 days of incubation.
- Measurement of potential estimators of P_o mineralization → P_o in the coarse fraction of the soil (CF) (>53 µm) (suggested by Ciampitti et al., 2013); C respiration (suggested by Ciampitti et al, 2013; Achat et al., 2010)

RESULTS

P_o in the Coarse Fraction (CF) as an Estimator of P_o Mineralization

There was a positive association between P_o in the CF and P_o mineralized in 6 and 13 days measured by isotopic dilution (Figure 1). This association was not observed when evaluating other potential estimators such as total P and P_o in non-fractionated soil samples, total P in the coarse fraction, microbial P, or phytate-like P (data not shown). The association in day 1 was not significant probably due to the un-steady state caused during soil labeling (at day 0).

C Respiration as an Estimator of P_o Mineralization Rate

The association between respiration rates (mg C kg^{-1} d^{-1}) and mineralization rates (mg P kg^{-1} d^{-1}) was statistically significant (Table 1) but presented a low coefficient of determination. The incorporation of the C_t:P_o ratio of the soil (non-fractioned) did not improve the model significantly. However, the incorporation of the C_t:P_o ratio of the CF to the model significantly improved the coefficient of determination.

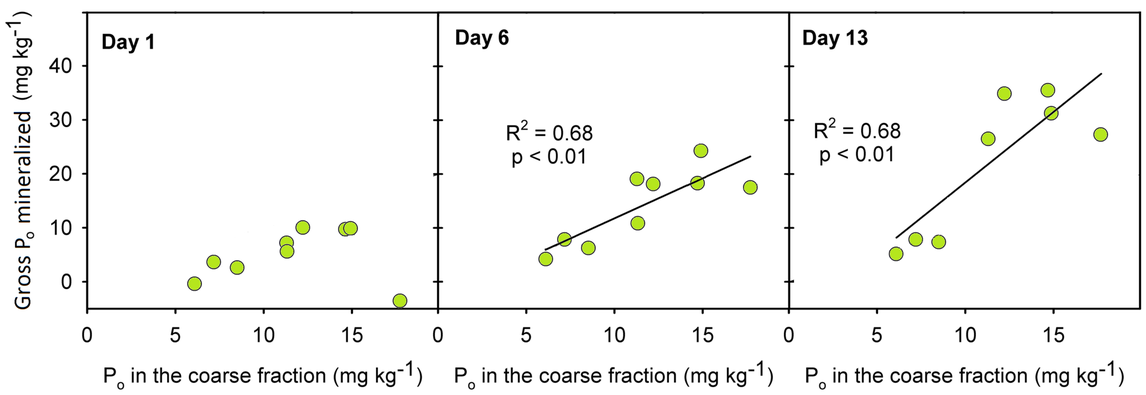

Figure 1. Association between organic phosphorus in the coarse fraction (CF) of the soil and the cumulative gross P_o mineralization measured by isotopic dilution after 1, 6 and 13 days of incubation

Table 1. Linear models to estimate gross P_o mineralization rate (P_{min}) using respiration rate and C_t:P_o ratio of the non-fractioned soil or the coarse fraction ($C:P_{total}$ and $C:P_{CF}$, respectively) as regressors

	Model	Significance level (*p*)	R^2
Respiration (Resp)	Gross P_{min} = 0.26 + 0.24 $Resp^{\dagger}$	0.0015	0.48
Resp + $C:P_{Total}$	Gross P_{min} = 0.82 + 0.24 $Resp^{\dagger}$ – 0.01 $C:P_{Total}$	0.0036	0.53
Resp + $C:P_{CF}$	Gross P_{min} = 1.7 + 0.20 $Resp^{\dagger}$ – 0.0049 $C:P_{CF}^{\dagger}$	0.0001	0.72

Conclusions

The concentration of P_o in the CF of the soil (>53 µm) was significantly related to P_o mineralization measured by isotopic dilution. Thus, the concentration of P_o in the CF surges as a promising indicator to differentiate soils according to their P_o mineralization potential, without focusing on the actual rate of mineralization which will be affected by other factors such as temperature and water content. In order to estimate P_o mineralization rates, we recommend to measure soil respiration and correct it by the C_t:P_o ratio of the CF.

Acknowledgments: This work was partly supported by the Swiss National Science Foundation (grant no. 3100A0-122141), the International Plant Nutrition Institute (IPNI), and grants funded by the UGA graduate school and the Fulbright commission