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Indirect determination of soil-specific conversion factor for soil microbial phosphorus

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Phosphorus (P) is an essential nutrient for plant growth. Low P availability in soils requires high demand for P as fertilizer and boosts searching for alternative P sources. Soil microbial phosphorus (P_{mic}) comprising up to 25% of total P is considered as a significant P stock. However, global storage and local importance of P_{mic} has not been estimated yet due to the absence of sufficient and reliable data. This is mainly because of the absence of standard method like those for microbial C and N. Another challenge is the necessity to determine soil-specific correction factor (Kp) for incomplete P release from cells, as application of the literature value (0.4) or no correction leads either to under- or overestimation of P_{mic} and related pools and fluxes.

Aiming to improve P_{mic} accuracy without direct Kp determination by ^{33}P or ^{32}P labeling, we conducted correlation analysis between soil specific Kp values available in the literature and soil parameters followed by forward stepwise regression analysis.

The soil-specific Kp values collected from literature have strong dependence (R^2=0.45-0.76) on soil properties, whose relevance decreases in the order P_{tot} > C_{org} > pH > Clay content.

The negative linear regression ($p<0.05$ R^2=0.76) reflects the decrease of extracted P_{mic} with the P_{tot} increase. An exponential increase of Kp with decreasing organic C (R^2=0.60) revealed a threshold of 10 g C_{org} kg^{-1},below that the determination of soil-specific Kp values is very important. The Kp dependence on pH describes best (R^2 =0.60) by a quadratic function, with a minimum at pH 6.9. Combining three soil parameters ($P_{tot,}$ C_{org} and Clay) in multiple regression: Kp = 0.76 - 0.007*C_{org} - 0.56*P_{tot} + 0.004*Clay enables to get an excellent prediction (R^2 = 0.99).

The improvement of Kp will help to get more precise data in the new studies as well as re-calculate the old ones. Therefore, in the absence of a soil-specific Kp, we recommend using the regression models obtained in a forward stepwise analysis and suggested in our study. They will strongly refine the microbial biomass P calculation and consequently improve quantification of the microbial P transformation processes: P immobilization, net P mineralization and P_{mic} turnover rates.

Keywords: forward stepwise analysis, microbial phosphorus, Kp, organic carbon, total phosphorus.