SOIL Discuss., referee comment RC2
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Comment on soil-2021-127

Chiara Pistocchi (Referee)

Referee comment on "The distribution of phosphorus from phosphorus derived materials to different soil fractions determines the phosphorus availability in the soil" by Yuan Wang et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-127-RC2, 2022

The manuscript of Wang and colleagues reports the effect of four organic amendments/fertilizers on phosphorus (P) pools in two different soils assessed through an incubation experiment. The soil P pools are investigated by sequential P fractionation and 31P solution nuclear magnetic resonance (NMR). The subject is relevant and timely as it deals with the recycling of P in order to reduce the use of mineral P fertilizers, which are produced from non-renewable resources. Although the manuscript is well structured and the experiment is well designed, some major points need to be addressed before publication. See specific comments.

Specific comments:

The main issue in my opinion is the lack of mechanistic interpretation of the reported findings. The effect of organic amendments or fertilizers on soil P has been investigate by several studies, see the non-exhaustive list of references reported below. The authors need to highlight better how their work allows advancing in the understanding of mechanisms driving P availability after the addition of organic amendments and what is the general interest of their research. This issue is also evident from the lack of scientific questions or hypotheses in the introduction, where only operational goals are reported (L98-103)

Motavalli, P., and R. Miles. "Soil phosphorus fractions after 111 years of animal manure and fertilizer applications." *Biology and fertility of soils* 36.1 (2002): 35-42.

Waldrip, Heidi M., Zhongqi He, and M. Susan Erich. "Effects of poultry manure amendment on phosphorus uptake by ryegrass, soil phosphorus fractions and phosphatase activity." *Biology and Fertility of Soils* 47.4 (2011): 407-418.

Halajnia, Akram, et al. "Phosphorus fractions in calcareous soils amended with P fertilizer and cattle manure." *Geoderma* 150.1-2 (2009): 209-213.

Kashem, Md Abul, Olalekan Oluwole Akinremi, and Geza Joseph Racz. "Phosphorus fractions in soil amended with organic and inorganic phosphorus sources." *Canadian Journal of Soil Science* 84.1 (2004): 83-90.

Brod, Eva, et al. "Waste products as alternative phosphorus fertilisers part I: inorganic P species affect fertilisation effects depending on soil pH." *Nutrient Cycling in Agroecosystems* 103.2 (2015): 167-185.

Brod, E., Øgaard, A.F., Haraldsen, T.K. *et al.* Waste products as alternative phosphorus fertilisers part II: predicting P fertilisation effects by chemical extraction. *Nutr Cycl Agroecosyst* **103,** 187–199 (2015). https://doi.org/10.1007/s10705-015-9731-4

A second point is about the recycled fertilizer/amendment material: why these specific materials were chosen? For example, why including maize straw, which is commonly left in the field and therefore do not constitute an external P input? In addition, these materials are poorly characterized. The total NPK contents are not sufficient to characterize these materials as already pointed out by the first reviewer. Information concerning the repartition between inorganic and organic P as well as the water-soluble or bicarbonate-soluble P forms in the fertilizers should be provided. I wonder why the sequential extraction was not performed on these products. A more detailed characterization of the applied material would help a more mechanistic interpretation of the results. Additional variables, such as dissolved and total organic carbon in these products, would help interpret the results. Dissolved organic compounds, for example might displace some adsorbed phosphorus, thus increasing its availability. The discussion Section "Large variability for soil P availability…" would greatly benefit and be less speculative if a more detailed characterization of the organic materials was performed.

The third point concerns the data analysis and other soil variables. The Olsen P and labile P fractions from the sequential extraction are correlated in the structural equation model because the P extracted with these two procedures is largely the same (L232-234 and L343-344). For this reason, it is confusing to state that "the labile P fractions and the moderately labile P fractions had positive effects on soil Olsen P" (L232-233) and other similar expressions. To provide a more mechanistic understanding using the SEM, it would be useful to include independent soil variables, such as clay content, iron oxides content, soluble organic carbon (which is expected to vary with the addition of organic material), which are all known to influence the sorption/desorption reactions of P in soils and therefore its availability.

It is also not clear which data were used to build the SEM, i.e. corresponding to which time points of the incubation.

Finally, language editing is needed, paying attention also to terminology. For example, the P fractions are most of the time called labile/moderately labile etc., but sometimes the words “stable” or “active” or “inert” are used. This might create confusion, as these terms are not specifically defined. I suggest adopting a consistent terminology throughout the manuscript. Another point: according to their NPK content, some of the organic products, ex maize straw, are technically amendments and not fertilizers.

Minor comments:

Please check throughout the manuscript the numbers after the decimal point in the percentages (sometimes zero, sometimes one or two numbers are shown, ex line 181, line 200, line 206) and homogenise to significant precision.

L45-46: “the attendant environmental…” unclear formulation, please revise

L58: “it also affects” not clear what it refers to

L79-80: there are many papers published on the effect of organic fertilizers/amendments on soil P fractions (see the non-exhaustive list above). I suggest checking and integrating this literature into the introduction

L109-112: other properties of the two soils such as the mineralogy or at least the texture would be useful, as well as a classification of the soils such as according the international World Reference Base (WRB)

L117: please, specify whether the P and K concentration in the products are given as P2O5 and K2O or as P and K. It is always preferable to express them as P and K, see:

Lambers, Hans, and N. J. Barrow. "Pervasive use of P2O5, K2O, CaO, MgO, and basic cations, none of which exist in soil." *Biology and Fertility of Soils* 56.6 (2020): 743-745.

L127: please, specify to what the percent of soil moisture is referred to, e.g. water holding capacity or soil weight …

L122-123: what is the rationale of this quantity of P added?

L143: “quantitation” is rather “quantification”?

L184: what are these ranges referred to? Is that the time points?

L190: “soil P fractions” instead of “fractionations”

L191-192 and L214: does the P added was completely recovered in the extracted fractions or not? This information is not easy to infer from table 2 or figure 3 but it would be useful to verify how much of the added P was not accounted for in the sequential extraction end ended up into non-extractable P.

L225-226: “and more inositol… both soils” awkward formulation, please re-word

L226 “supplemented both soil”, please reformulate

L269: what “drab soil” means?

L279 “found rapid integration” please, reformulate this sentence

L307-310: please refer to the supplementary figure showing pH values.

L343-344: The P extracted with the Olsen extractant largely overlaps with the labile fractions of the sequential extraction. See also the third main point.

Tables and figures

Table 2: I am surprised by the very good precision of the measurements in some fractions, such as in the NaOH-Po, for which, in my experience, the variability usually is quite large. Are those analytical or real replicates?

Not all the figures in supplementary materials are referenced in the text