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Reply on CC1

Yuan Wang et al.

Author 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-AC3, 2022

Dear Dr. Leinweber,

We greatly appreciate your time and expertise in reviewing our manuscript (soil-2021-127). We have carefully modified the manuscript based on your constructive comments, which significantly improve the manuscript. Appended is our point-by-point response to the comments. The detailed information is as follows:

1. 27: The manures and maize straw are P-containing materials but not P fertilizers, sensu stricto.

Thanks for the nice suggestion. We agree with you and have modified this expression throughout the text.

37: Overall, the concluding sentence is very general. Reader in fact remains uninformed, which is novel in this study. No explanation is given for the descriptive findings. For instance, cattle manure performed best but what is the "considerable practical significance" of this finding in P-recycling? ... Using all cattle manure as soil amendments = done anyway; raising more cattle ...? Or, is this an overall meaningless phrase? Authors are vague in their conclusions or remain almost unclear.

Thanks. Based on your suggestion we have significantly revised the conclusions and highlighted our main findings.

46: What in detail are "the attendant ... quality issues"? Vague expression, meaningless if no more details are given.

Thanks. We have corrected this sentence in the modified manuscript. A modified version is shown as follows: excessive application of phosphate fertilizer is a common phenomenon, which leads to soil P accumulation, water pollution, and crop quality decline.

64/65: For increases and decreases explained here, different bases were used (proportions vs. contents). Thus, the meaning of this statement is unclear. Proportions cannot be directly compared with contents/concentrations.

Thanks. Based on the comments We revise the sentence as follows: Also, application of organic fertilizer increased the proportion of labile organic phosphate (Po) and inositol hexaphosphate (IHP) but decreased stable Ca-associated P proportion.

66-69: This literature evaluation is incomplete and rather selective. For sure, much more is known about P in manures and similar materials. All this should have been compiled to disclose real knowledge gaps and lay a basis for the present study. Here it reads rather vague, like "effects are complex and need to be studied". That is not a strong rationale for a laborious scientific study.

Thanks. As suggested by the reviewers, we have deleted the first sentence and revised the sentence as follows: The P fractions in manure are dependent on various factors, including manure type, solid-liquid separation status, manure removal method, handling way and degree of decomposition, etc (Li et al., 2014a; Pagliari and Laboski, 2013). Especially for manure type, the differences in the digestive system and feed composition of different animals cause large differences in P concentration and fractions in different manures (Garcia-Albacete et al., 2012; Freiberg et al., 2020). Meanwhile, straw turnover is usually applied directly to the soil in agricultural practice, and the P availability in straw requires in-depth analysis (Guan et al., 2020). The bone meal which can be recycled and used as a large amount of organic fertilizer in the future remains unclear in terms of P reuse (Ylivainio et al., 2008). Thus, it is necessary to identify and quantify P fractions from different P-containing materials and their distribution in soil P fractions to determine the potential bioavailability of P from various sources.

63-74: Again, references are very incomplete. Much more is known, even on the soil, the authors mention at l. 75, 76.

As suggested by the reviewers, we have supplemented relevant information in the Introduction section.

73: "contents ... are influenced ...".

Thanks. The initial description has been modified as follows: the relative contents of inorganic and organic P in soil were greatly affected by soil type, land use and the type of organic amendment applied.

74-76: Weak conclusive rationale for the study. What is meant by "edaphic conditions"?

Thank you for your suggestion. We modified the sentence as follows: it is valuable to reveal the transformation mechanism of different P-containing materials in soil and its relationship with soil properties by studying the difference of P fractions in a typical red soil (low pH) and a fluvo-aquic soil (slightly alkaline pH) with different P-containing materials.

76: "Hedley fractionation" is slang. It is a sequential P fractionation after Hedley et al., modified by Tiessen… It is a division of total soil P into fractions, not fractions into fractions. Imprecise explanation.

Thanks. We modified the sentence accordingly.

78/79: This reference refers to "a subtropical region". For evidencing "wide use" some review articles should have been cited at least (I recommend reading first Cross & Schlesinger).

Thank you for the suggestion. We have supplemented the references related to P fractions in other research regions.

79-82: 2 contrasting statements in 1 sentence but references are not assigned to each of the statements. Unclear for the reader…

Thank you. The reference has been modified.

83 ff. As already criticized above for the P fractionation, the literature review of 31P NMR is very selective and fragmentary. For instance, not any study of P in manures and other P recycling materials has been mentioned although many of such studies have been published.

Thank you for the comments. We have supplemented the relevant studies as follows: Previous studies reported that the solution ^{31}P-NMR procedure detected more phytic acid in poultry manure than that in cattle manure (Li et al., 2014b; Jayasundera et al., 2005).

96: When introducing the soils, authors should use internationally understandable soil units, like the WRB system. "Red" indicates Ferralsols or ferric subunits of other Major Soil Units, developed from intensive weathering under subtropical/tropical climate conditions. By contrast to this system, "Red" as such is not an internationally accepted soil classification; same with "fluvo-aquic" (if not in combination with a WRB unit). This imprecision is hard to understand, considering that the WRB System and secondary literature on it refer to the P issues in great detail.

We agree with these comments. We have supplemented the details of these two soils in the materials and methods, to provide a reference for the wider application of this study. The modified as follows: Soil samples were collected from fluvo-aquic soil (calcareous alluvial soil) in Hebei Province and red soil (ultisol) in Yunnan Province. The soil texture of fluvo-aquic soil is silt loam soil with 7.9% of clay (<2 μm), 55.3% of silt (2–20 μm), and 36.8% of sand (20–2,000 μm). The soil texture of red soil is clay with 47.5% of clay (<2 μm), 25.3% of silt (2–20 μm), and 27.2% of sand (20–2,000 μm).

97: "Little is known" is a phrase very often used, but this phrase is meaningless if authors do not communicate what in detail (even if it is not much) is known (and what is unknown but important to know).

Thank you for pointing this out. We have modified it as follows: quantifying the variation of soil P availability on the time scale and in different soil types (representative of acidic and alkaline soils) is worth further investigation.

100-103: Authors write what they did but they do not report what they intended to find out or what their research hypotheses were. Overall, my impression of the INTRO text is "vague", "not very well-reviewed" and "immature" in how the rationale for the study was tried to develop.

We would like to thank the reviewer for her critical and constructive comments. The research objectives and hypothesis has been redrafted at the end of the introduction section. We hypothesized that□(1) Compared with MS, CB, and PM, CM is more efficient renewable P-containing materials. (2) Compared with fluvo-aquic soil, different P-containing materials are more easily fixed in red soil. (3) The difference in potential bioavailability of P from various sources is determined by their distribution to soil labile P fractions.

2. MATERIALS & METHODS:

Soil materials should be described in terms of WRB units and soil horizon origin. Instead of "Olsen" the detailed extractant should be given.

Thanks for the constructive comments. We have supplemented the material methods section with more details on soil properties and Olsen-P extractant.

116-117: This is confusing; better assign the concentrations to each of the materials.

Apologies for this confusing information. We have modified this accordingly.

138-142: Unclear how Pt and Pi were determined if Po is the difference Pt-Pi? The description should be clear and understandable without checking Figure S1.

Thank you for your suggestion. We have modified it as follows: The concentration of Po is equal to the concentration of total P (Pt) minus the concentration of inorganic P (Pi).

143: variation? I do think that ^{31}P NMR can quantify species.

Thank you for your suggestion. The title has been modified.

148: contains the incomplete sentence

Thank you for pointing this out. The sentence has been modified as follows: the solution pH was adjusted to 9.0±1.0, kept steady for 30 min, and again centrifuged at 12000 g

(20 □) for 30 minutes.

3. 176: First of all, I see in Fig. 1, that the differences which appear at the end of incubation are more or less already obvious at the starting point. That indicates that the results reflect inherent properties of the materials added, rather than - or in addition to – the interactions with soil particles. Therefore, the study is incomplete without giving the analyses results for the non-amended soils (maybe controls) and amendments (prior to addition to soil). The study would gain scientific value if the authors would be able to distinguish between effects of materials composition and interaction with soil (the latter leading to differences between soils (… for which details of mineralogy must be known).

Thank you for these valuable comments. The analysis and discussion of these data have been supplemented in the modified manuscript accordingly.

180 ff: Differences between treatments better should be explained as factors. Data as percent bear the risk of confusion if the basis for calculation is unclear.

Thank you for your suggestion. The expression has been modified as follows: During 0-70 days of incubation, the Olsen-P concentration of SSP, PM and CM enriched fluvo-aquic soil has increased by 49.5 $mg \cdot kg^{-1}$, 21.7 $mg \cdot kg^{-1}$, and 34.4 $mg \cdot kg^{-1}$ compared with CK in average, respectively. In SSP, PM, and CM enriched red soil, the Olsen-P concentration was increased by 29.9 $mg \cdot kg^{-1}$ 15.3 $mg \cdot kg^{-1}$ and 23.8 $mg \cdot kg^{-1}$ compared with CK on average during 0-70 days of incubation, respectively. CM outperformed other renewable P-containing materials in increasing Olsen-P concentration. In fluvo-aquic soil, the Olsen-P concentration of soil with CM was significantly increased by 12.7 $mg \cdot kg^{-1}$, 34.5 $mg \cdot kg^{-1}$, and 34.24 $mg \cdot kg^{-1}$ on average compared with PM, MS, and CB, respectively. In red soil, the Olsen-P concentration of soil with CM was significantly increased by 8.5 $mg \cdot kg^{-1}$, 25.3 $mg \cdot kg^{-1}$, and 19.4 $mg \cdot kg^{-1}$ on average compared with PM, MS, and CB, respectively.

177: Olsen P cannot be "improved". This is bad slang. The concentration of NaHCO3-extracted be can be increased by a factor of ... (= more precise explanation)

Thank you for pointing this out. The expression has been modified as follows: based on the effect size, treatments could be grouped into (1) those that significantly increased Olsen-P concentration and (2) those that slightly or insignificantly increased Olsen-P concentration, following soil enrichment with different P-containing materials.

179-180: Bad wording; better assign factor of increase to each treatment.

Thank you for pointing this out. We have modified it accordingly.

Sorry authors, here I stop reading/revising your manuscript. In my view, it is too immature to be seriously reviewed. As a reviewer, I feel wasting my time with your text. A greatly improved version, developed and written with much more care, should be submitted which starts with a thorough revision of the pertinent literature, logical deriving knowledge gaps and rationales for study, and testable hypotheses.

We sincerely accept these criticisms. The main objective of this study is to provide a basis for the closed- P cycle in farming systems by recovering P from agricultural wastes. We attempted to explore promising renewable P-containing materials for achieving a closed cycle of P by understanding the transformation dynamics of different renewable P-containing materials in soil and their P availability. The soil texture and physicochemical properties such as pH and organic matter determined the P sorption reaction (Xiong et al., 2022; Debicka et al., 2016; Bouray et al., 2021). Quantifying the transformations of different P-containing materials in soils with different soil conditions is necessary to enhance P utilization and reduce P resource limitation. We have supplemented this background in the introduction.

To understand the transformation dynamics of different P-containing materials in the soil, we measured the P fractions of the initial soil, four renewable P-containing materials, and two soils with different P-containing materials on days 0,35, and 70 of incubation. As mentioned by the reviewers, the differences which appear at the end of incubation are more or less already obvious at the starting point. The P fractions were not significantly different on day 70 of incubation compared to day 0 of incubation. Therefore, we analyzed the data from day 70 of incubation in manuscript. However, we did not realize that these data are indispensable to understanding the mechanisms of transformation of different P-containing materials in two soils. The analysis and discussion of these data have been supplemented in the modified manuscript. These comments have greatly improved our manuscript. We believe that this study is valuable and meaningful for understanding the mechanisms of P-containing material transformation in different soils.

4. CONCLUSIONS

339: This is not new but has been shown in many previous studies.

340-348: None of this is a conclusion but almost all repetition of the previous text. The reader cannot find any original new information from this section.

343-344: This is not surprising but could be expected because of the same extractant (weak $NaHCO_3$-solution) in sequential extraction and the so-called Olsen method. As such, it is a meaningless result.

We express our sincere appreciation for your careful work and thoughtful suggestions. These comments were valuable and helpful in revising and improving the manuscript. The abstracts have been significantly revised and the conclusions have been rewritten.

The conclusions were modified as follows: Compared with other renewable P-containing materials, CM is a superior source for improving soil P availability in fluvo-aquic and red soils. Compared to fluvo-aquic soil, phosphorus from SSP, PM, and CM was more strongly immobilized in red soil. Further analysis of the P fraction of two soils with different P-containing materials at days 0,35 and 70 of incubation revealed that the distribution of CM to the soil labile P fraction was significantly increased compared to other renewable P-containing materials. And compared with fluvo-aquic soil, the contribution of different P-containing materials to the labile P fraction of red soil was significantly decreased. Changes in P fractions at different incubation periods in soils with different P-containing materials show that most soil P fractions have no significant difference on day 70 of incubation compared to day 0 of incubation. That suggests, in the short term, the difference of potential bioavailability of P from various sources is determined by the distribution to soil labile P fractions rather than its transformation in the soil. In general, there is promising potential to reduce P limitation by recovering cattle manure as an alternative source of P supply. This study provides a basis for closing the P cycle in agricultural systems and for sustainable on-farm P management strategies.

Thank you again for your suggestions and help, and we look forward to receiving your suggestions for our revised manuscript again.

References of response to referee comments

Bouray, M., Moir, J. L., Lehto, N. J., Condron, L. M., Touhami, D., and Hummel, C.: Soil pH effects on phosphorus mobilization in the rhizosphere of Lupinus angustifolius, Plant and Soil, 469, 387-407, https://doi.org/10.1007/s11104-021-05177-4, 2021.

Debicka, M., Kocowicz, A., Weber, J., and Jamroz, E.: Organic matter effects on phosphorus sorption in sandy soils, Archives of Agronomy and Soil Science, 62, 840-855, https://doi.org/10.1080/03650340.2015.1083981, 2016.

Freiberg, Y., Fine, P., Levkovitch, I., and Baram, S.: Effects of the origins and stabilization of biosolids and biowastes on their phosphorous composition and extractability, Waste Management, 113, 145-153, https://doi.org/10.1016/j.wasman.2020.06.002, 2020.

Garcia-Albacete, M., Martin, A., and Cartagena, M. C.: Fractionation of phosphorus

biowastes: Characterisation and environmental risk, Waste Management, 32, 1061-1068, https://doi.org/10.1016/j.wasman.2012.02.003, 2012.

Guan, X. K., Wei, L., Turner, N. C., Ma, S. C., Yang, M., and Wang, T. C.: Improved straw management practices promote in situ straw decomposition and nutrient release and increase crop production, Journal of Cleaner Production, 250, 119514.119511-119514.119513, 2020.

Jayasundera, S., , W. F. S., III, J. B. R., and Dao, T. H.: Direct 31P NMR spectroscopic measurement of phosphorus forms in dairy manures, Journal of Food, Agriculture & Environment, 3, 5, 2005.

Li, G., Li, H., Leffelaar, P. A., Shen, J., and Zhang, F.: Characterization of phosphorus in animal manures collected from three (dairy, swine, and broiler) farms in China, PLoS One, 9, e102698, https://doi.org/10.1371/journal.pone.0102698, 2014a.

Li, G. H., Li, H. G., Leffelaar, P. A., Shen, J. B., and Zhang, F. S.: Characterization of Phosphorus in Animal Manures Collected from Three (Dairy, Swine, and Broiler) Farms in China, Plos One, 9, https://doi.org/10.1371/journal.pone.0102698, 2014b.

Pagliari, P. H. and Laboski, C. A. M.: Dairy manure treatment effects on manure phosphorus fractionation and changes in soil test phosphorus, Biology and Fertility of Soils, 49, 987-999, https://doi.org/10.1007/s00374-013-0798-2, 2013.

Xiong, J., Liu, Z. H., Yan, Y. P., Xu, J. L., Liu, D., Tan, W. F., and Feng, X. H.: Role of clay minerals in controlling phosphorus availability in a subtropical Alfisol, Geoderma, 409, https://doi.org/10.1016/j.geoderma.2021.115592, 2022.

Ylivainio, K., Uusitalo, R., and Turtola, E.: Meat bone meal and fox manure as P sources for ryegrass (Lolium multiflorum) grown on a limed soil, Nutrient Cycling in Agroecosystems, 81, 267-278, https://doi.org/10.1007/s10705-007-9162-y, 2008.