Soil
Manuscript No.: SOIL-2021-105
Manuscript Title: Effects of returning corn straw and fermented corn straw to fields on the soil organic carbon pools and humus composition
Article Type: Research paper
Authors: Yifeng Zhang, Sen Dou, Batande Sinovuyo Ndzelu, Rui Ma, Dandan Zhang, Xiaowei Zhang, Shufen Ye, Hongrui Wang

Topical Editor Comments to the author

Comments to the author:
Dear Authors,
the revised manuscript was very improved but still needs minor revisions before publication.
English editing is strongly required especially in the new sentences added within the revision.
The second point is that Introduction should be still reduced to the most important points that drive the reader to understand the state of the art and the main gaps that lead to formulate the hypotheses and the objectives of the work.
Conclusions remain a summary of results rather than highlighting the conclusive remarks obtained by the current findings.
Thus I ask the Authors to make these changes before proceeding to publication.

Best regards,
Luisella Celii

Response to Topical Editor comments

Dear Editor Luisella Celi,

First of all, on behalf of all co-authors, we appreciate your positive and constructive comments and suggestions on our manuscript submitted to SOIL. You have given us invaluable advice, from the preliminary review stage, the interactive discussion stage, and the revision stage.
The English of the manuscript was thoroughly revised by one of the co-author (Batande Sinovuyo Ndzelu) a native English speaker. We revised the entire manuscript with the special attention paid at the newly added sentences.

The Topical Editor comments are laid out below and specific concerns have been numbered. Please find changes and explanations point by point below in **Blue**. All changes in the revised manuscript are made using Track Changes to make reviewing easy. We believe that our new revised version of the manuscript has been much improved.

Yours sincerely,
Dr. Yifeng Zhang

Topical Editor specific comments

(page, line: comment)

- **Comment 1:** English editing is strongly required especially in the new sentences added within the revision.

Response: We have asked that a native English co-author (Batande Sinovuyo Ndzelu) to thoroughly revise the English of the manuscript, particularly the newly added sentences. And all English editing changes in the revised manuscript are made using Track Changes in blue to make reviewing easy.

- **Comment 2:** The second point is that Introduction should be still reduced to the most important points that drive the reader to understand the state of the art and the main gaps that lead to formulate the hypotheses and the objectives of the work.

Response: Thank you for the suggestion. We have reduced the Introduction to the most important points that shows the state of the art and main points we are trying to show the reader. Consequently, the introduction part of the manuscript reduced from 1118 to 937 words, while not changing important parts of the original revision. We have made revisions and updates in the text as follows (**page 1, line 19-page 3, line 69**):

Text: "**1 Introduction**

Recycling and returning crop residues as soil amendments is an important prospect for increasing soil organic carbon (SOC) content and crop yield (Villamil et al., 2015), and managing crop straw residues. However, the decomposition process is slow when crop residues are directly applied to the soil (Zhang et al., 2019), and it is still not fully known how crop residues are transformed into stable SOC when applied to the soil (Cotrufo et al., 2013; Lehmann and Kleber, 2015; Zhang et al., 2015a). Information about the decomposition and stability of carbon (C) is needed for long-term soil C sequestration (Cotrufo et al., 2013; Ndzelu et al., 2020a). Contrary to direct crop residue application and conventional composting methods, pre-treatment of crop residues with microbial inoculants is an effective method for reusing crop residues as eco-friendly amendments to improve soil fertility and increase soil organic matter (SOM) (Bhattacharjya et al., 2021; Organo et al., 2022). This strategy accelerates crop residue degradation and humification (Vargas-Garcia et al., 2006; Ahmed et al., 2019; Nigussie et al., 2021; Sajid et al., 2022) by significantly halving the time needed for the compost to reach maturity (Organo et al., 2022). The microbial inoculant-based fermentation product contains both labile organic substances from the degraded portion and relatively stable humic-like substances (Huang et al., 2008). This favours the accumulation and production of SOM when applied to the soil (Vargas-Garcia et al., 2006; Ahmed et al., 2019).

The labile organic C components are sensitive and respond promptly to changes in soil management practices (Blair et al., 1995; Xu et al., 2011). Hence, the labile organic C fractions such as water extractable organic carbon (WEOC), easily oxidizable organic carbon (EOC), and microbial biomass carbon (MBC) are

effectively used to detect small changes in soil quality (Chen et al., 2009; Sainepo et al., 2018). Chen et al. (2017) and Ma et al. (2021) reported a significant increase in MBC and WEOC contents after crop straw residues were returned to the soil. In another study, Ndzelu et al. (2020b) also found that five years of corn straw application increased soil EOC, WEOC, and MBC contents by 34.09%, 41.38%, and 49.09% in the 0 – 20 cm depth, respectively. Therefore, assessing labile SOC fractions after crop straw applications may provide information about the formation of SOC (Chen et al., 2009; Huang et al., 2018; Liu et al., 2019; Ma et al., 2021). The carbon pool management index incorporates carbon pool index and carbon pool activity index, and is an important and sensitive index widely used to determine changes in SOC and C sequestration in the soil (Blair et al. 1995; Duval et al. 2019). A high carbon pool management index indicates that soil management practices have agreater potential to promote soil Csequestration (Duval et al. 2019).

The humic substance is the most stable fraction of SOM and contributes the largest proportion to the total SOC (Olk et al., 2019; Dou et al., 2020). As a result, studying changes in soil humus components and the labile organic C fractions after corn straw application could inform about the formation and stabilization of SOC during crop residue decay. Over the years, extensive studies have been conducted to investigate the effects of crop residues on SOM and its pools (Atiyeh et al., 2002; Romero et al., 2007; Zhang et al., 2015a; Ng et al., 2016; Yang et al., 2020). However, there are still conflicting reports and there is no consensus about the effects of crop residue application on the formation and composition of SOM. For instance, recent studies have found that corn straw application significantly increases soil humus content and enriches soil humic acid structure with aromatic compounds (Fan et al., 2018; Zhang et al., 2019). In contrast, other studies reported increased aliphatic compounds in soils amended with corn straw (Yang et al., 2020; Ndzelu et al., 2020a). These diverging reports indicate that the magnitude and the influence of corn straw residues on SOM composition are unclear and site-specific.

Trichoderma-mediated straw fermentation is gaining attention as a soil amendment and nutrient source (Gaind and Nain. 2006; Gaind and Nain. 2007; Siddiquee et al., 2017) because of the role *Trichoderma*-mediated straw play in improving crop yield (Islam et al., 2014), promoting plant development, and alleviating biotic and abiotic stresses in crops (Sarangi et al., 2021). In our previous studies (Yang et al., 2019; Zhang et al., 2020; Zhang et al., 2021), we observed in laboratory incubation experiments that the *Trichoderma reesei* (*T. reesei*) had the best ability to form humic acid-like during corn straw decomposition when compared with other fungi (*Phanerochaete chrysosporium* and *Trichoderma harzianum*). However, there is limited knowledge on the potential effects of *T. reesei* fermented corn straw on SOM formation and accumulation. In particular, the dynamic change process of different SOC fractions has not been sufficiently reported after soils are amended with T. reesei fermented corn straw. In this study, we quantified differences in soil organic carbon pools and humus composition between treatments. The purpose of this study was to verify whether the application of fermented corn straw treated with *T. reesei* is more effective in forming a relatively stable SOC fraction in a field experiment compared to

the direct application of corn straw. We hypothesized that: (1) application of fermented corn straw treated with *T. reesei* (FCS-T) will be the most efficient in increasing soil humus content and soil C storage, due to the increase in aromatic C compounds; (2) application of FCS-T may also increase soil labile organic C components (WEOC, EOC, and MBC); and (3) application of FCS-T may increase carbon pool management index level more than direct corn straw application."

- **Comment 3:** Conclusions remain a summary of results rather than highlighting the conclusive remarks obtained by the current findings.

Response: Thank you for the suggestion. Following the comments of the editor, we rewrote the conclusions and highlighted the main outcomes and current findings of the study. Now the Conclusions reads as below (**page 10, line 283-301**):

Text: "**5 Conclusion**

In this 360-day field experiment, we applied corn straw (CS) and fermented corn straw treated with *Trichoderma reesei* (FCS-T) under equal C input, and a blank control treatment (CK) for comparison. The following conclusions were drawn:

The change of SOC content mainly depends on the C content of the stable soil components, i.e., aromatic compounds (HA-C and HM-C). The FCS-T material has a lower C/N ratio, higher alkyl and aromatic C content, and humic-like substances. When the FCS-T material is applied to the soil, it is more advantageous in promoting the soil humification process and increasing soil HA-C and HM-C content. Compared with direct corn straw application (i.e., CS treatment), the FCS-T treatment increased the SOC content by 1.715 g kg^{-1} on the 360^{th} day, and increased the PQ value to 74.1%. The application of FCS-T material with a lower C/N ratio sequestered more SOC than the application of CS, which supported the idea that the C/N ratio in the organic amendments is negatively correlated with SOC content.

The application of FCS-T significantly improves the release of soil labile carbon components. In particular, the WEOC content could maintain a high level for a long time, while the EOC and MBC contents of FCS-T treatment increased significantly more than CS treatment on the 60^{th} and 90^{th} days.

Compared to CS treatment, the FCS-T treatment significantly improved the level of carbon pool management to 13.95, primarily by promoting the simultaneous increase in the contents of EOC and stable organic carbon components (HA-C and HM-C).

The results confirmed our initial hypothesis that the application of FCS-T has a greater potential to increase soil carbon sequestration compared with direct application of CS. As a method of returning straw residues to the field, the application of FCS-T is a practice worthy of further exploration."

Adjustments other than Topic editor comments

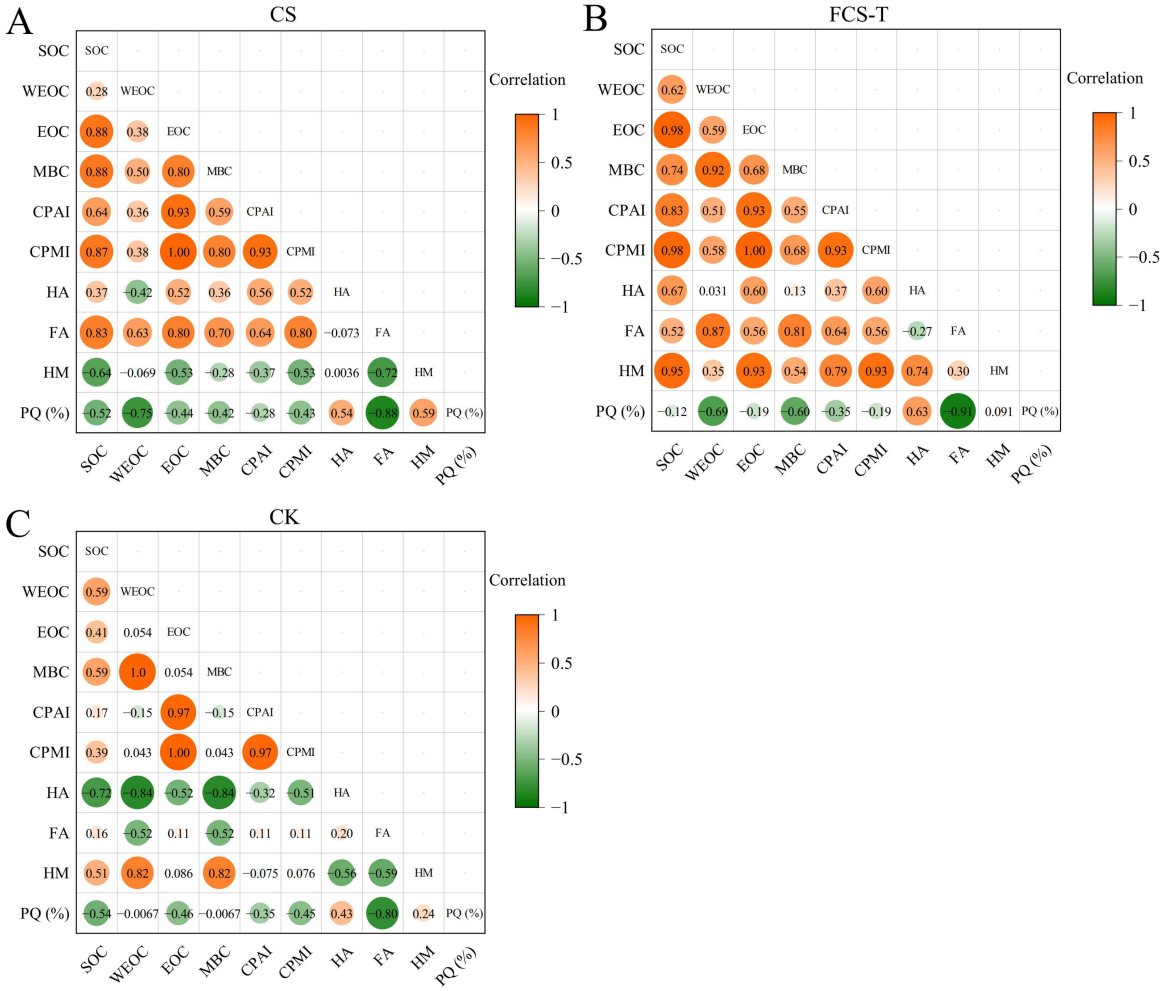
- The clarification regarding the changes in co-author affiliations

Response: Although the two co-authors (Batande Sinovuyo Ndzelu and Xiaowei Zhang are now attending new institutions, they were at Jilin Agricultural University when they participated in this study. So all the co-authors jointly decided not to show affiliations b and c.

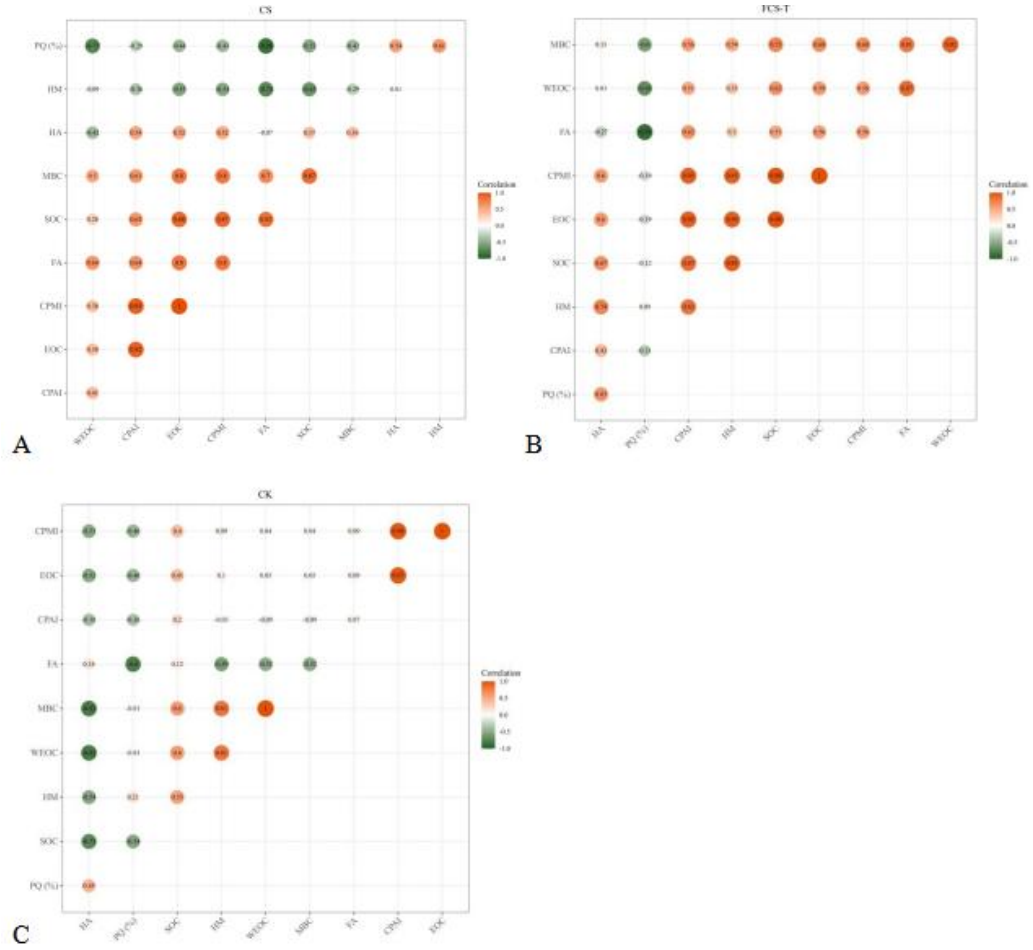
- The clarification regarding the changes of Figure 7

Response: The Figure 7 of the previous version of the manuscript was too small to read. We have therefore changed the Figure 7 to a more readable size without making changes to the data its self. we have only improved the quality of Figure 7 to make it easier to read, and the new version and past version are as follows:

New version:



Past version:



Thank you very much for your consideration.
Kind regards,
(Yifeng Zhang)