

Response to Reviewers

We are very grateful to the editor and reviewers for their insightful comments and suggestions on our manuscript. We have carefully revised the manuscript according to your guidance. Key improvements include: (1) Explicitly addressing the three hypotheses in the Discussion; (2) Correcting all noted typos and formatting issues; (3) Revising the keywords to eliminate redundancy with the title; and (4) Clarifying the statistical methods and sampling depths. A detailed point-by-point response is provided below.

Abstract

Comment 1: L9–11, The authors stated that “Multiple regression analyses identified soil available phosphorus (AP) and pH as the key interactive drivers of CO₂ emissions, in the following order: CDCS > SLS > GLCS > FWCS.” If I am not mistaken, this is not addressed in the Results. Please check this and, if necessary, correct it.

Response: We appreciate the reviewer’s careful reading. We apologize for the previous ambiguity. To clarify: the descending order of CO₂ emissions (CDCS > SLS > GLCS > FWCS) was empirically determined from the incubation measurements (Figure. 4) and reported in lines 230-232, whereas the identification of soil available phosphorus (AP) and pH as the primary drivers was derived from multiple regression analysis (Section 3.3). We have revised the abstract and added explicit statements in the results section to clearly distinguish between the observed emission pattern and the statistical identification of its drivers. The revised sentence reads:

“The cumulative CO₂ emissions followed the descending order: chicken dung compost (CDCS) > sludge compost (SLS) > goat manure-leaf compost (GLCS) >

food waste compost (FWCS). Multiple regression analyses identified soil available phosphorus (AP) and pH as the key interactive drivers of CO₂ emissions.” (lines 9-12)

Comment 2: L15 – I believe the correct word is “physico-chemical” and not “physic-chemical”.

Response: We agree and have corrected “physic-chemical” to “physico-chemical” throughout the manuscript (Line 15 and elsewhere).

Graphical abstract

Comment 3: There is a typo in the word “moisture”.

Response: We have corrected the typo in the Graphical Abstract. Thank you for pointing this out.

Keywords

Comment 4: There is a typo in “Available phosphoru”.

Response: We have corrected the typo to “Available phosphorus”.

Comment 5: There is an overlap between the keywords and the title. I suggest choosing keywords that are not already in the title.

Response: We appreciate this suggestion. The keywords have been revised to avoid duplication with the title, as follows:

Soil incubation; Carbon dioxide emission; Regression analysis; Nutrient availability; Organic amendment

Introduction

Comment 6: L34 – The abbreviation SOC is used for “soil carbon sequestration”, but it is commonly used for “soil organic carbon”. Please check.

Response: We agree. We have replaced “soil carbon sequestration (SOC)” with “carbon sequestration” (Line 34).

Comment 7: L67–74 – Three hypotheses were presented but not explicitly addressed in the Discussion.

Response: We thank the reviewer for this important comment. We have now explicitly addressed each hypothesis in the Discussion section (Lines 333–337). A summarizing paragraph was added to clearly state that all three hypotheses were supported by the experimental and statistical results.

Materials and methods

Comment 8: L93 – The authors refer that soil was sampled at “10 to 20 cm depth”. Does this mean that the sampling depth was between the surface (0 cm) and a depth between 10 to 20 cm, or does this mean that sampling depth was between 10 cm and 20 cm?

Response: We apologize for the ambiguity. We have revised the text (Lines 93–98) to explicitly state that sampling was conducted exclusively from the 10–20 cm subsurface layer, excluding the 0–10 cm topsoil. We also added the scientific rationale, explaining that the exclusion of the surface layer was necessary to minimize spatial heterogeneity and ensure a homogenized baseline for evaluating the compost effects.

Comment 9: L105–108 – Present compost characteristics in a table.

Response: We have moved the compost physico-chemical properties to Table 1 in the in the main text (Lines 110–115).

Comment 10: L105 – Please remove the blank space after the number (0.42).

Response: Thank you for pointing this out. The extra space after “0.42” has been removed.

Comment 11: L111 – If my interpretation is correct, 1:9 and 1:39 (w/w) are equivalent to 10% and 2.5% (w/w). For better clarity, I suggest that the authors present the ratios in a single way (e.g. 2.5% and 10% (w/w)).

Response: We have unified the presentation to 2.5% and 10% (w/w) throughout the manuscript.

Comment 12: L117–118 – – The authors refer 14 measurement times but only 12 are shown.

Response: We thank the reviewer for catching this inconsistency. The correct number of sampling events is 12, and the text has been corrected accordingly (Line 121).

Comment 13: L119-This information is repeated from the previous sentence/paragraph.

Response: Thank you for pointing this out. Redundant sentences were removed.

Comment 14: L122-123 – The authors referred that “The CO₂ emissions from soil were captured with NaOH and subsequently quantified by back-titration.” This was already mentioned in the previous sentence.

Response: We thank the reviewer for noticing this redundancy. The duplicate sentence has been removed from the revised manuscript. The trapping of CO₂ with NaOH and its quantification by back-titration after BaCl₂ precipitation are now described clearly in a single sentence (see Lines 123–125, revised manuscript).

Comment 15: L123-124 – The authors mentioned that “This established method involved precipitating the trapped CO₂ as barium carbonate”. However, in the previous sentence they refer that NaOH was used to trap the CO₂. Please clarify/correct this.

Response: We apologize for the unclear description of the analytical procedure. We have revised the text (Lines 123–125) to explicitly clarify the sequence of steps. We now specify that BaCl_2 was added to precipitate the trapped carbonate as BaCO_3 prior to the titration of the residual NaOH . This revision clarifies that NaOH served as the trapping agent, while the formation of BaCO_3 was an intermediate step necessary for the quantification process.

Comment 16: L136–138 – The methods that were used should be explained in more detail (here or in Supplementary Material)

Response: We thank the reviewer for this suggestion. We have expanded the statistical methods section to provide more detailed information. For ANOVA, we have added the verification of normality (Shapiro-Wilk test) and homogeneity of variances (Levene's test) with their respective criteria. For the regression analysis, we have detailed the diagnostic procedures for residual normality (Shapiro-Wilk test, histogram, and P–P plot), residual independence (Durbin-Watson statistic), and multicollinearity (tolerance and VIF), as well as the ridge regression approach used to address collinearity. All supplementary figures and tables are now properly cited (lines 138-144 and lines 150-160).

Comment 17: L136-138 – Normality of residues is also an ANOVA assumption. Have the authors evaluated it? If so, please add the details. Additionally, have the ANOVA assumptions of homogeneity of variances and normality of residues always occurred? If not, what was the procedure followed by the authors? Have they also used non-parametric tests (e.g. Kruskal-Wallis' test)

Responds: We thank the reviewer for raising this important statistical point. In the revised manuscript, we have clarified that normality of residuals was assessed using the Shapiro-Wilk test, and homogeneity of variances was evaluated using Levene's

test prior to conducting one-way ANOVA (Lines 139–144). For most soil parameters, residuals were approximately normally distributed ($p > 0.05$) and variances were homogeneous. In a few cases where assumptions were mildly violated, ANOVA remained robust due to equal sample sizes and symmetric distributions (Blanca et al., 2017). Nevertheless, to ensure the reliability of our conclusions, we additionally performed the non-parametric Kruskal–Wallis H test for parameters with substantial deviations (AK, EC and AP), and the results were consistent with those of ANOVA (Supplementary Tables S4 and S5).

Blanca, M.J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2017). Non-normal data: Is ANOVA still a valid option. *Psicothema*, 29(4), 552–557. <https://doi.org/10.7334/psicothema2016.383>

Results

Comment 18: L153 – There is an extra “.” at the end of the sentence. Please remove it. Additionally the reference to Figure 1 occurs in 2 consecutive sentences which, in my opinion, is excessive.

Response: We thank the reviewer for pointing this out. We have removed the extra “.” at the end of the sentence as well as the repeated “Figure 1” was deleted in the revised manuscript.

Comment 19: L153–155 – This interpretation should be included in Discussion and not in Results.

Response: We have kept only the objective description of Figure 1 in the Results section and moved the interpretative statement regarding compost alleviation of soil compaction to the Discussion (lines 285-290), as suggested.

Comment 20: L161 – There is an extra “.” Please remove it.

Response: We thank the reviewer for pointing out this typo. The extra period has been removed.

Comment 21:L160-162 – This remark should be included in the Materials and Methods section, not in the figure legend.

Response:We agree with the reviewer. The mentioned remark has been moved from the figure 1 legend to the appropriate subsection within the Materials and Methods section (lines 131-134).

Comment 22:Tables 1 and 2 – For better clarity and flow, I suggest including means, standard deviations, statistical letters, F-values, and p-values in the same table. Additionally, the legend has an extra blank space. Please remove it.

Response:We appreciate this suggestion for improving clarity. Tables 1 and 2 have been revised to present the means, standard deviations, statistical letters, F-values, and p-values in a single, combined format (Table 2 in the revised manuscript). We have also removed the extra blank space from the table legend.

Comment 23:Table 2 – The meaning of “df” should be indicated.

Response:We have added a clear definition for “df” (degrees of freedom) to the footnote of Table 2 in the revised manuscript.

Comment 24: L171-173 – The second part of the sentence (“and for each compost type, the 10 % addition gave significantly higher values than the 2.5 % addition ($p < 0.05$).”) can already be inferred from the first part (“increasing the compost addition rate from 2.5 % to 10 % consistently enhanced the concentrations of all three nitrogen forms”). Please check this redundancy.

Response:We thank the reviewer for pointing out this redundancy. We have revised the sentence to remove the repetitive second clause. The revised text now states: "Furthermore, increasing the compost addition rate from 2.5% to 10% consistently

enhanced the concentrations of all three nitrogen forms ($p < 0.05$).\" This change eliminates unnecessary repetition while retaining the key statistical information.

Comment 25:Figure 2 – There is a typo in electrical conductivity. Additionally, the unit “siemens” is represented by a capital S (dS/m) and not by a lower case s.

Response:We thank the reviewer for catching these errors. The typo in "electrical conductivity" has been corrected in Figure 2. We have also changed the unit from "ds/m" to the correct notation "dS/m" (with a capital S for Siemens) in accordance with standard SI unit conventions.

Comment 26:Figure 2 – The authors wrote that “Data are presented as mean $\pm$ SD”. However, this is a figure, not a table. Therefore, the +/- sign should not be included here.

Response: We thank the reviewer for this valuable suggestion. In the revised figure, we have removed the “ $\pm$ SD” notation and will instead present the data as means with error bars representing the standard deviation, which is more appropriate for a figure.

Comment 27:L173-174 – The authors refer that “the original soil showed no significant difference between $\text{NH}_4^+\text{-N}$ and $\text{NO}_3^-\text{-N}$ ”. I believe that the meaning of this is understandable. However, in my opinion, it is not accurately expressed as the authors did not statistically compare the levels of $\text{NH}_4^+\text{-N}$ and $\text{NO}_3^-\text{-N}$. I believe that what the authors meant was that the levels of both variables were similar. Additionally, this information is supported by Figure 2. However, the reference to that figure was not included here.

Response:We agree with the reviewer that the original phrasing was imprecise. We have revised the statement to: "Notably, while the levels of $\text{NH}_4^+\text{-N}$ and $\text{NO}_3^-\text{-N}$ in the original soil were similar (Figure 2a), compost-treated soils exhibited consistently

lower $\text{NH}_4^+\text{-N}$ than $\text{NO}_3^-\text{-N}$ across all application rates, indicating that compost addition promoted the nitrification process in the ARC-soil system. (lines 176-178)" This avoids implying a statistical comparison that was not performed and correctly cites Figure 2a to support the observation.

Comment 28:L176 – Considering that the authors are moving from the N-related to the P-related variables, the 2 sentences should be divided by a paragraph.

Response: We agree that a new paragraph is warranted here for better flow. A paragraph break has been inserted at the start of Line 181 to separate the discussion of nitrogen and phosphorus variables.

Comment 29: L175-176 – The authors wrote “As shown in Figure 2(b), the ARC-soil had an AP content below the instrument detection limit”. I did not find any information regarding detection limits in Figure 2. Please check this.

Response:We thank the reviewer for this comment. To avoid making a claim that requires a detection limit marker in the figure, we have revised the sentence to: "As shown in Figure 2(b), the ARC-soil had a negligible AP content..." in the revised manuscript (line 182)

Comment 30:L202 – There is a misplaced “.”

Response:The misplaced period at L202 has been removed.

Comment 31: L206 – The CEC results should start in a new paragraph.

Response:We agree. A new paragraph has been started at Line 216 to introduce the CEC results.

Comment 32: L211 – The “C” and the “O” in CO₂ should be capital letters.

Response: We have corrected the formatting of "CO₂" to have capital "C" and "O" at L221.

Comment 33:Figure 3 – Please check the legend, as the “(a)” is repeated and there are 2 “.” at the end.

Response:We have corrected the legend for Figure 3. The duplicate "(a)" and the double period at the end have been removed.

Comment 34: L212-213 – The authors wrote that “Throughout the first two weeks of incubation, CO₂ emissions from FWCS, GLCS, CDCS, and SLS remained consistently higher than those from ARC-soil”. It was not only during the first 2 weeks but during all the 90 days.

Response:We thank the reviewer for catching this inaccuracy. Upon re-examining our data in Figure 3, we agree that the higher CO₂ emissions from compost-amended soils compared to the ARC-soil persisted throughout the entire 90-day incubation period, not only during the first two weeks. We have revised the sentence accordingly to: "Throughout the entire 90-day incubation period, CO₂ emissions from FWCS, GLCS, CDCS, and SLS remained consistently higher than those from the ARC-soil (line 222).

Comment 35:L217 – The “.” is repeated at the end of the sentence.

Response: The duplicated period at the end of L217 has been removed.

Comment 36: Figure 3 – For an easier comparison, I would suggest that the 2 figures should have the same y-scale. The same is applicable to Figure 4.

Response:This is an excellent suggestion for improving data visualization. We have

revised Figures 3 and 4 so that the panels (a) and (b) within each figure now share the same y-axis scale to facilitate direct comparison.

Comment 37: Figure 5 – The legend of this figure should be improved. For example, what does the number inside each correlation matrix represent? Are they Spearman or Pearson correlation coefficients? What do the authors mean with “(b) statistical significance”?

Response: We have significantly improved the legend for Figure 5. The revised legend now reads: Pearson's correlation matrix of soil physico-chemical properties and their relationships with cumulative CO₂ emission. (a) Correlation coefficients (R values), with colors indicating the direction and strength of correlations (blue: positive; red: negative). (b) Statistical significance levels, with darker colors indicating significant correlations at the $p < 0.05$ level and lighter colors indicating non-significant correlations.

Comment 38: L245-268 – These are technical details that, in my opinion, are misplaced here. Instead, they should be presented in Supplementary Material.

Response: We agree with the reviewer that the detailed tables and figures are more appropriate for supplementary material. Accordingly, we have moved Tables 3-5 and the associated Figure 6 in original manuscript to the Supplementary Material (now Supplementary Tables S1–S3 and Supplementary Figure S1). The main text now presents only a concise summary of the key findings, with clear references to the corresponding supplementary items to guide readers who wish to consult the detailed data.

Comment 39: Tables 3 to 6 – More information needs to be added to the legends. Most of the information in these tables do not have enough relevance to be shown in

the manuscript. Therefore, I would suggest to extract the most relevant information from those tables and include it in a single one. The remaining information can be moved to Supplementary Material.

Response: We thank the reviewer for this suggestion. We have removed Tables 3 to 5 from the main text in the original manuscript and moved them to the Supplementary Material as Supplementary Tables S1 to S3. In the main text, we now briefly summarize the regression results with appropriate references to the supplementary tables. The legends of these supplementary tables have been expanded to include full definitions of all abbreviations (e.g., Adj-R², S.E., df).

Comment 40: Figure 6 – Please check my comments above regarding Tables 3 to 6 and L245-268.

Response: We have carefully considered Figure 6 in light of the reviewer's comments on Tables 3–6 and L245-268. We agree that this figure presents supporting data rather than a core finding of the study. Therefore, we have moved Figure 6 to the Supplementary Material (now Supplementary Figure S1).

Comment 41: L280 – I believe “Y” represent CO₂ emission. However, this should be clearly indicated. The same is applicable to the Figures and Tables where Y is shown.

Response: We thank the reviewer for pointing this out. We have clearly defined “Y” as cumulative CO₂ emission in the main text at Line 278 by adding the sentence: “In the regression equation, Y represents cumulative CO₂ emission.”

Discussion

Comment 42: The adjusted R^2 is very high. I suggest that the authors briefly explore the implications of this in the Discussion.

Response: We thank the reviewer for this valuable suggestion. We have added a brief discussion on the implications of the high adjusted R^2 (0.902) in section 4.2. Specifically, we now state: “The high adjusted R^2 (0.902) demonstrates that the selected physico-chemical properties are strong predictors of cumulative CO_2 emission, collectively accounting for the vast majority of the observed variance. This confirms that compost-induced changes in these soil properties are closely linked to enhanced microbial activity.”(lines 310-312)

Comment 43:L286-300 – The authors did not evaluate microbial activity directly linked to N-cycling. CO_2 production can be related to microbial activity, but not necessarily to microbial activity directly linked to N-cycling. Therefore, in my opinion, this should be revised.

Response: We thank the reviewer for this important clarification. We have revised the relevant statement in Section 4.1 to avoid over-interpreting our data. Instead of directly stating that compost "stimulates microbial processes related to nitrogen cycling," The revised text reads as follows: " Secondly, compost application significantly altered soil nitrogen dynamics, as reflected by the decreased NH_4^+ -N and increased NO_3^- -N levels in all compost-treated soils (Figure 2a), suggesting enhanced nitrification. This is consistent with the findings of Zhang et al. (2015), who reported that ..."

Comment 44:Supplementary Material – I noticed that the authors included Supplementary Material. However, it is not referenced in the manuscript.

Response: We thank the reviewer for noticing this omission. We have now included

appropriate citations to the Supplementary Material throughout the main text (e.g., “(Supplementary Table S1)” or “(Supplementary Figure S1)”) wherever relevant.