Revision EGUSPHERE-2025-5065

Point by point response to the Editor and reviewer #3:

We would like to express our sincere gratitude to the Editor and reviewer for their constructive and insightful comments. We have carefully revised and improved the manuscript accordingly. The point-by-point responses are presented below, with line numbers referenced to the **clean version** of the manuscript.

Public justification

The revised manuscript makes some important improvements but the referee feels that the analysis oversteps the inference that can be made with the available measurements and I am inclined to agree. Careful measurement of soil fluxes is important, but also important to describe in the context of the full ecosystem carbon balance to draw the correct level of inference for what the measurements are saying. I still feel like a revised version of the manuscript could represent an improvement but please carefully note the referee comments and prepare a revised manuscript accordingly.

Response: We are extremely grateful to the editor for affirming the research content of our article, for providing us with the opportunity for revisions, and for giving us patient guidance on our work. Based on the main issues highlighted in this round of feedback, we have made more precise and rigorous revisions to the entire content, which mainly include the following four parts of modifications.

1. ***We have clarified that the focus of this study is the effect of green manure intercropping on soil CO_2 emissions in tea plantations. Accordingly, all descriptions of fluxes throughout the manuscript have been rigorously revised to the more specific term "soil CO_2 fluxes from tea plantations."***

   Details can be found in the tracked-changes version of the manuscript.

2. ***In the revised manuscript, we have clearly distinguished between "direct measurement results" and "inferences based on measurements." Key modifications are summarized below:***

   "Multivariate analysis identified soil organic carbon (SOC) and temperature as dominant flux drivers, hinting at a possible SOC threshold that warrants further validation." *(Lines 35-37)*

"Compared to CK, intercropping reduced tea-row emissions by 7.1–7.9% but increased inter-row emissions by 12.7–28.9% based on the two years cumulative emissions, continuous intercropping exhibited a trend of reducing inter-row CO_2 emissions, indicating its potential mitigation value." *(Lines 37-40)*

"Moreover, the NO_3^-–N concentration in the SMG treatment was 14.56 mg·kg^{-1}, which was significantly higher than that in other treatments (Fig. 6e). This was because the organic nitrogen input by the high biomass of *Vulpia myuros* C. increased nitrate nitrogen production through mineralization, and its well-developed root system improved soil aeration and inhibited denitrification." *(Lines 582-586)*

"The net increase in soil CO_2 emissions under the HM treatment was smaller than that under the SM treatment, which may be attributed to the more effective suppression of fertilization-induced emission peaks by the HM treatment." *(Lines 635-638)*

3. ***We have carefully revised several inferences, toned down overreaching conclusions, and placed relevant discussions in the context of the whole tea plantation ecosystem. Key modifications are summarized below:***

"Our findings suggest a potential SOC threshold that may influence whether soil CO_2 emissions increase or decrease, though this requires further validation." *(Lines 643-645)*

"These results highlight spatially heterogeneous soil CO_2 flux and suggest that green manure intercropping has long-term potential as a climate-smart practice for soil carbon management in tea plantations." *(Lines 40-43)*

"Overall, green manure intercropping (particularly the mixed intercropping of legumes and grasses) can significantly alter the spatial pattern of soil CO_2 emissions in tea plantations, achieving emission reductions in tea row areas while increasing emissions in inter-row areas. This underscores the importance of incorporating spatial emission weights into carbon accounting for tea plantation ecosystems. Meanwhile, the co-benefits of green manure intercropping, such as soil improvement, reduced fertilizer application, and weed suppression, make it a practical and multifunctional strategy for low-carbon tea plantation management." *(Lines 645-653)*

4. *We have added a discussion of uncertainties and limitations. A new subsection,* **5.2 Limitations and Future Directions,** *has been included at the end of the manuscript. This subsection describes the limitations of the present study and provides perspectives for future research. Within the context of the whole tea plantation ecosystem, we outline key issues that should be addressed in future studies on green manure intercropping in tea plantations, including the need to incorporate measurements of photosynthesis, vegetation dynamics, and biomass accumulation, as well as coordinated analyses of multiple greenhouse gas species. Such efforts will help generate integrated findings on the carbon balance of the entire tea plantation ecosystem and ultimately support the development of low-carbon tea plantations under green manure intercropping systems.*

"**5.2 Limitations and Future Directions**

This study focused on the effects of different green manure treatments on soil CO_2 emissions in tea plantations, specifically monitoring soil respiratory CO_2 fluxes under different treatments. However, this approach cannot represent the whole-tea-plantation CO_2 balance. Soil respiration accounts for only a portion of the CO_2 exchange in tea plantation ecosystems; thus, CO_2 budgets from processes such as photosynthesis and litter decomposition also need to be monitored. Therefore, to address greenhouse gas emissions from the entire tea plantation ecosystem under different green manure management practices, more in-depth long-term field monitoring is required in the future. Observations should encompass multiple ecosystem scales (e.g., atmosphere, vegetation, and soil) and a broader range of greenhouse gases (e.g., CO_2, N_2O, and CH_4), so as to more comprehensively reveal the carbon mitigation effects."

First, coordinated monitoring of the whole-ecosystem carbon budget including soil respiration, photosynthesis, vegetation carbon pools, green manure biomass, and litter decomposition is needed to establish a complete carbon accounting framework for tea plantations. Second, long-term fixed-site observations of key greenhouse gases (CO_2, N_2O, and CH_4) should be conducted across diverse ecological backgrounds to assess the adaptability and mitigation potential of green manure intercropping. Third, future field experiments should integrate tea yield, quality, and economic indicators alongside greenhouse gas measurements. This will enable the development of a comprehensive carbon balance evaluation system that quantifies the contribution of green manure intercropping to net ecosystem carbon exchange, thereby providing scientific evidence and practical guidance for establishing low-carbon tea plantations." *(Lines 655-677)*

In response to Reviewer 3's comment: "*My main concern remains unchanged: I am not convinced that this study actually addresses greenhouse gas (GHG) emissions.*" We respectfully note that this specific concern was not strongly emphasized in the first round of review. In the initial comments, Reviewer 3 only raised a brief question regarding our static chamber measurements. As described in our Methods section, this study focuses specifically on the effects of different green manure treatments on **soil CO_2 emissions** from tea plantations, i.e., soil respiration under different treatments. We are fully aware that CO_2 alone does not represent total GHG emissions, as GHGs encompass multiple components (CO_2, CH_4, N_2O, CO, etc.). Furthermore, ecosystem-scale CO_2 emissions from tea plantations include aboveground and belowground processes, atmospheric deposition, and anthropogenic inputs, representing an integrated outcome of the atmosphere, vegetation, and soil. Our results do not represent total GHG emissions from the entire tea plantation ecosystem, nor do they represent ecosystem-scale carbon fluxes. We have provided a detailed description in the Methods section, clarifying that the conventional static chamber method was used primarily to measure soil respiration, including root and soil microbial respiration. Therefore, all descriptions of CO_2 fluxes in tea plantations throughout this manuscript refer to soil respiration under different green manure intercropping treatments. We believe that the revisions made to the full manuscript in this round will enable readers from diverse backgrounds to understand the focus of the study.

After carefully reading Reviewer 3's comments from both rounds of review, we think that the issues raised by Reviewer 3 are mostly straightforward and addressable. However, we note that the reviewer's reports appear to contain over-critical evaluations that may led to some unfair evaluations. Our reasons are as follows:

First, after reading Reviewer 3's second-round comments, we found that the newly raised issues are also largely straightforward and addressable. Apart from a few simple modification issues, some of the questions are even basic, common knowledge issues in the field of greenhouse gas monitoring. Examples include: "negative fluxes cannot occur with chamber measurements," "whether chambers should be fixed at the same position," "whether chamber measurements can address whole-ecosystem GHG emissions," "whether interactions between factors in ANOVA have been validated," and "the difference between flux and cumulative emission." In our view, these are all simple and basic conceptual questions within the field. While we can provide detailed explanations in our response, it appears that the reviewer may have directly questioned the validity of our study and recommended rejection without a clear understanding of these basic concepts. This raises the possibility of an unfair assessment. Much of our response to Reviewer 3's comments in this round essentially serves as an educational introduction to greenhouse gas monitoring knowledge.

Second, in the first round of review, all of Reviewer 3's comments could be adequately addressed. None of the issues raised were fatal to the study. Overall, the tone of the first report seemed positive. Nevertheless, the reviewer recommended rejection. We responded point-by-point to each comment, carefully revising the manuscript in full compliance with the reviewer's suggestions. Despite these substantial improvements to the experiments, methods and content of the article, the second-round "Report" was even more negative, ignoring the clear progress made in the revision.

Third, in the second round, Reviewer 3 suddenly raised a "main concern" that the reviewer claimed had been consistent. We find this surprising because this issue likely stems from a misunderstanding of the scope of our study. As clearly stated in our Methods section, this study focuses on soil CO_2 emissions from tea plantations under different green manure treatments. All descriptions of CO_2 fluxes in tea plantations throughout this manuscript refer to soil respiration under different green manure intercropping treatments. It does not aim to address total GHG emissions from the entire tea plantation ecosystem. We are genuinely puzzled that, despite having access to our detailed methodological description, the reviewer continues to misinterpret the reported CO_2 fluxes as representing total greenhouse gas emissions from the entire tea plantation ecosystem. We believe this round of revisions will allow readers from diverse backgrounds to fully understand the focus of the study.

Fourth, in the second report, Reviewer 3 criticized that our discussion of economic and policy implications was overly speculative. This was exactly the aspect that Reviewer 3 had asked us to expand in the first round. We believe that, based on our long-term monitoring data, quantifying the differences in CO_2 emissions among different green manure treatments and providing treatment-specific mitigation recommendations already represents a novel contribution and advances low-carbon tea plantation research. As our study lacks empirical economic or policy data, such discussion can only be framed as perspectives. Thus, Therefore, the suggestions from these two rounds of review are to some extent contradictory.

We remain grateful that some of Reviewers 3's comments have contributed to the improvement of the article. But we respectfully submit that during the review process, Reviewer 3 may have misunderstood the scope and objectives of the study. Some of the comments are logically unclear and contradictory. Given many of the issues raised are simple and basic questions in the field, it appears that the reviewer may have over-critically evaluated the manuscript. We kindly hope that the Editor will comprehensively review the comments provided by Reviewer 3, examine our responses and revisions to all reviewers, and render a fair and scientific evaluation of our work.

Anonymous Referee #3

I appreciate the effort that went into revising this manuscript, but I have to be honest that I am still not convinced by the revision. In its current form, I do not think the study is suitable for publication. My main concern remains unchanged: I am not convinced that this study actually addresses greenhouse gas (GHG) emissions, even though the manuscript is framed that way throughout. The CO_2 measured here represents total ecosystem respiration, not GHG emissions in the sense relevant to atmospheric forcing. As described in the methods, the flux reflects the gross exchange (not net exchange) of CO_2 from the system, which includes plant respiration, residue/litter fall decomposition, and soil respiration. CO_2 derived from plant biomass originates from photosynthesis and is part of the biogenic carbon cycle, so it should not be interpreted as a net GHG source. Because the chambers are dark, photosynthesis is excluded, meaning the measurements do not represent net ecosystem exchange. Under this setup, I do not see how the CO_2 fluxes can be interpreted as GHG emissions at the ecosystem level. This is a fundamental issue, and I strongly recommend removing any discussion or framing related to GHG emissions, as the experimental design cannot support those discussions and conclusions. Beyond this central issue, I also have concerns about the experimental design and statistical analysis. The CO_2 measurements include multiple sources, not just soil respiration, and this is not consistently acknowledged in the interpretation.

Response: We have revised the wording throughout the manuscript to be more rigorous and precise, avoiding potential misunderstandings by readers outside the relevant field regarding the core focus of our study. As noted earlier, ecosystem-scale CO_2 fluxes naturally encompass aboveground and belowground processes, atmospheric deposition, and anthropogenic inputs—this is basic knowledge in greenhouse gas monitoring, and we are fully aware of it. We have also provided detailed explanations in our methods section. However, this study specifically focuses on the effects of different green manure treatments on soil CO_2 emissions in tea plantations. We believe the reviewer, after reading our experimental methods, still misunderstood the main purpose of our study. Following the reviewer's suggestion, we have carefully revised all statements related to CO_2 emissions throughout the manuscript, specifying them as "soil CO_2 emissions from tea plantations."

"Static chambers were placed to cover tea plants, green manure plants, and the topsoil (0–15 cm). The monitored CO_2 fluxes represent the total ecosystem soil respiration of the tea plantation, e.g., autotrophic respiration from plant roots and heterotrophic respiration from soil microorganisms." (Lines 243-246）

The statistical approach is also not well aligned with the structure of the data. If fluxes were measured repeatedly over time, then a repeated measures framework would be more appropriate than a simple ANOVA. The study involves multiple factors, including treatment type, spatial position (tree row versus inter-row), and observation period, yet only a two-way ANOVA is described (lines 256). It is not clear whether interactions among these factors were tested. If significant interactions were present, then the statistical analysis that was used to generate stats results in Table 2; Figures 3, 5, and 6 would no longer be appropriate. In several places where comparisons are discussed, particularly between tree rows and inter-rows, it is unclear how the statistical analyses were actually conducted.

Response: We used multi-factor analysis of variance. Different figures and different results reveal the significance among various factors, with a primary focus on revealing the significance of differences in the interactions between the green manure treatment and other factors. Under this analytical objective, both two-way and three-way ANOVA were applied.

Table 1 presents the two-way ANOVA (green manure × season). Figure 3 presents the three-way ANOVA (green manure × spatial position × year). Figure 5 presents the two-way ANOVA (green manure × management practice and green manure × growth stage, respectively). The ANOVA procedure was conducted using codes that include all interaction terms, thereby simultaneously analyzing interactions; there is no issue of missing interaction terms. All interaction p-values were greater than the significance level (0.05), indicating that the interaction effects were not significant.

In Table 1, the p-value for the interaction term between different types of soil CO_2

flux and season_T in tea rows is 0.2081, and that between different types of soil CO_2 flux and season_G in inter-rows is 0.44662.

```
> summary(fenxi1)
                       Df Sum Sq Mean Sq F value   Pr(>F)    
factor(season_T)        3 175.02   58.34  96.767 1.53e-13 ***
type                    2   3.32    1.66   2.756   0.0837 .  
factor(season_T):type   6   5.57    0.93   1.540   0.2081    
Residuals              24  14.47    0.60                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> summary(fenxi1)
                       Df Sum Sq Mean Sq F value   Pr(>F)    
factor(season_G)        3 261.79   87.26  64.162 1.32e-11 ***
type                    2  19.99   10.00   7.350  0.00324 ** 
factor(season_G):type   6   8.18    1.36   1.002  0.44662    
Residuals              24  32.64    1.36                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In Figure 3, the p-value for the three-way interaction term of type * spatial * year is 0.509359.

```
> summary(fenxi1)
                  Df Sum Sq Mean Sq F value   Pr(>F)    
type               2  1.458   0.729   2.602 0.094857 .  
spatial            1 13.814  13.814  49.301 2.93e-07 ***
year               1  3.918   3.918  13.983 0.001015 ** 
type:spatial       2  3.763   1.882   6.715 0.004829 ** 
type:year          2  0.095   0.048   0.170 0.844648    
spatial:year       1  4.144   4.144  14.789 0.000777 ***
type:spatial:year  2  0.389   0.194   0.694 0.509359    
Residuals         24  6.725   0.280                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In Figure 5(a), the p-value for the two-way interaction term of different types of soil CO_2 flux and stage_T in tea rows is 0.782.

```
> summary(fenxi1)
                      Df Sum Sq Mean Sq F value   Pr(>F)    
factor(stage_T)        3 101.08   33.69  46.778 3.53e-10 ***
type                   2   3.13    1.57   2.176    0.135    
factor(stage_T):type   6   2.28    0.38   0.527    0.782    
Residuals             24  17.29    0.72                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In Figure 5(b), the p-value for the two-way interaction term of different types of soil CO_2 flux and stage_G in inter-rows is 0.080246.

```
> summary(fenxi1)
                       Df Sum Sq Mean Sq F value    Pr(>F)    
factor(stage_G)         3 219.98   73.33  46.807 3.51e-10 ***
type                    2  37.42   18.71  11.945 0.000251 ***
factor(stage_G):type    6  20.53    3.42   2.184 0.080246 .  
Residuals              24  37.60    1.57                      
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In Figure 5(c), the p-value for the interaction term between different types of soil CO_2 flux in tea rows and fertilization_T management is 0.166, between different types of soil CO_2 flux and grass planting_T management is 0.888, and between different types of soil CO_2 flux and pruning_T management is 0.06839.

```
> summary(fenxi1)
                            Df Sum Sq Mean Sq F value   Pr(>F)    
factor(fertilization_T)      1  40.36   40.36  63.437 3.93e-06 ***
type                         2   1.72    0.86   1.352    0.295    
factor(fertilization_T):type  2   2.66    1.33   2.089    0.166    
Residuals                   12   7.64    0.64                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> summary(fenxi1)
                       Df Sum Sq Mean Sq F value Pr(>F)  
factor(planting_T)      1  1.540   1.540   1.683 0.2189  
type                    2  9.108   4.554   4.978 0.0266 *
factor(planting_T):type  2  0.220   0.110   0.120 0.8880  
Residuals              12 10.977   0.915                 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> summary(fenxi1)
                      Df Sum Sq Mean Sq F value  Pr(>F)   
factor(pruning_T)      1 17.132  17.132  16.128 0.00171 **
type                   2  0.101   0.050   0.048 0.95376   
factor(pruning_T):type  2  7.186   3.593   3.382 0.06839 . 
Residuals             12 12.747   1.062                   
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

In Figure 5(d), the p-value for the interaction term between different types of soil CO_2 flux in inter-rows and fertilization_G management is 0.77125, between different types of soil CO_2 flux and grass planting_G management is 0.67584, and between different types of soil CO_2 flux and pruning_G management is 0.3117.

```
> summary(fenxi1)
                              Df Sum Sq Mean Sq F value  Pr(>F)   
factor(fertilization_G)        1 18.979  18.979  13.501 0.00318 **
type                           2 16.890   8.445   6.007 0.01557 * 
factor(fertilization_G):type   2  0.743   0.371   0.264 0.77215   
Residuals                     12 16.870   1.406                   
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> summary(fenxi1)
                         Df Sum Sq Mean Sq F value  Pr(>F)   
factor(planting_G)        1 28.417  28.417  11.156 0.00589 **
type                      2  0.614   0.307   0.121 0.88744   
factor(planting_G):type   2  2.063   1.031   0.405 0.67584   
Residuals                12 30.567   2.547                   
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> summary(fenxi1)
                        Df Sum Sq Mean Sq F value Pr(>F)  
factor(pruning_G)        1  12.38  12.377   5.558 0.0362 *
type                     2  12.32   6.158   2.765 0.1029  
factor(pruning_G):type   2   5.73   2.865   1.287 0.3117  
Residuals               12  26.73   2.227                 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

We revised Figures 3 and 5 to make them more accurate.

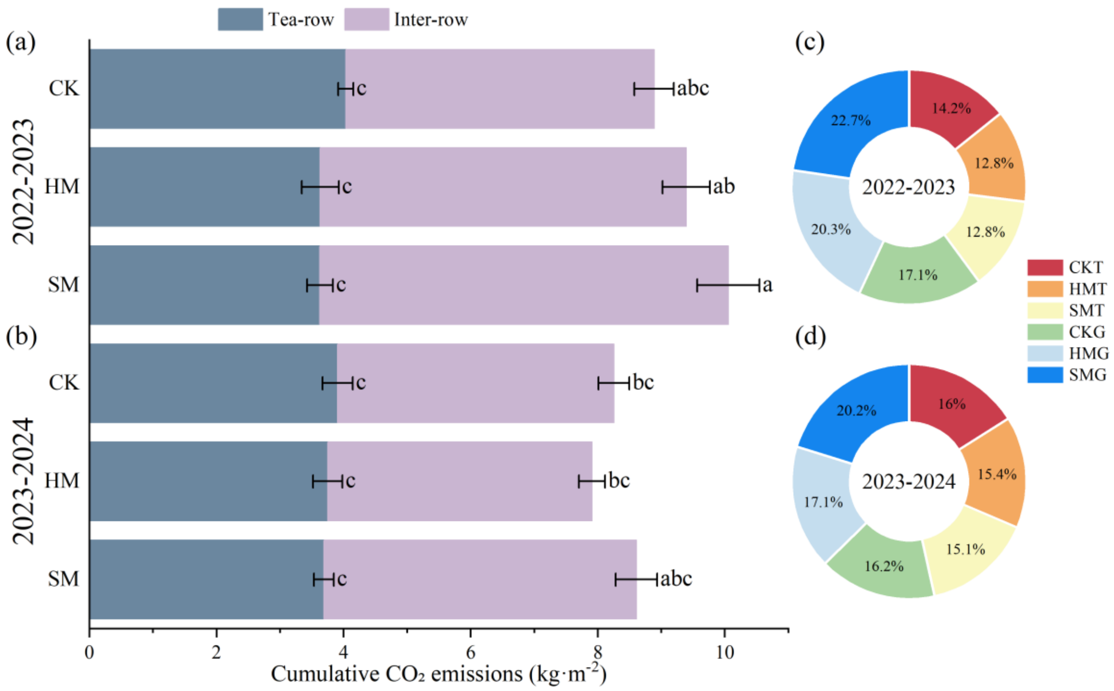

Figure 3. (a, b) Annual cumulative soil CO_2 emissions from tea rows and inter-rows under different green manure intercropping treatments; (c, d) contribution of tea rows and inter-rows to total annual soil CO_2 emissions under each treatment. Data shown are means ± SE. Different lowercase letters indicate significant differences (p < 0.05)

among all treatment combinations (type × spatial position × year) based on three-way ANOVA. CK for control; SM and HM for intercropping types, T for tea row, G for inter-row.

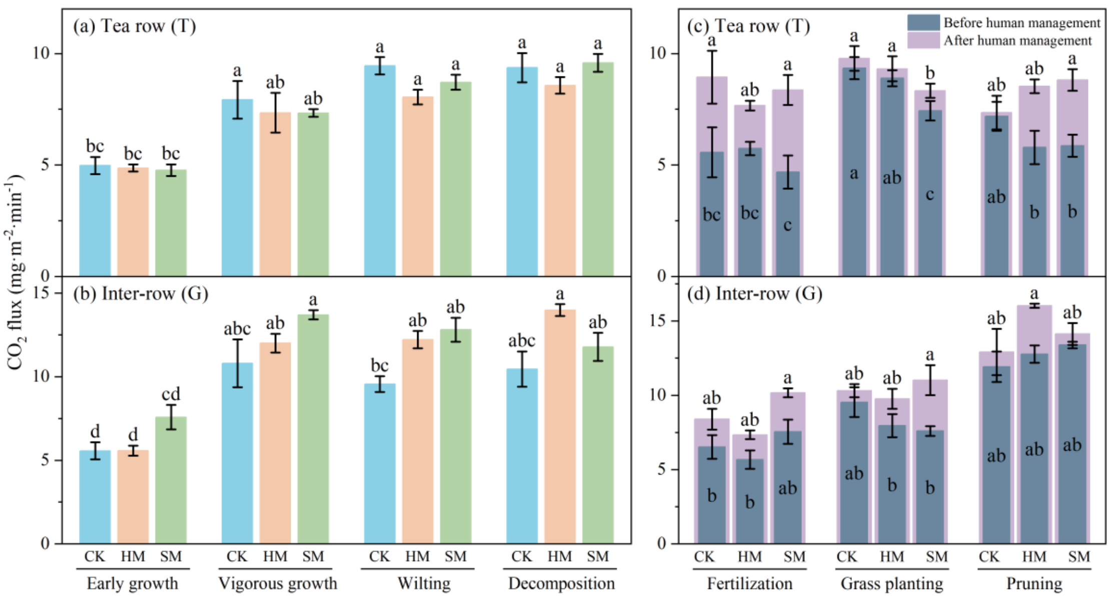

Figure 5. Temporal dynamics of soil CO_2 fluxes under green manure (a, b) growth stages and (c, d) management events in tea plantations. Growth stages include: early growth (mid-November to early April), vigorous growth (mid-April to late May), wilting (early June to late July), and decomposition (August). CK for control; SM and HM for intercropping types, T for tea row, G for inter-row.

I also find the results and discussion difficult to follow due to internal inconsistencies and unclear logic. It is often not clear whether the discussion refers to inter-row, tree row, or the entire system. There are places where statements directly contradict each other (e.g., lines 480–481 versus lines 520–522) and in many cases it is not clear whether differences are statistically significant (most often no significant difference showed between the discussed treatments based on the figures and tables).

Response: We have reviewed the entire manuscript and clearly specified all descriptions related to tea rows and inter-rows. Regarding original Lines 520-522, which discuss the effects of management practices and green manure growth periods, the description of summer should refer to a portion of the vigorous growth period rather than the entire summer season. This has been revised to "vigorous growth". The revised text is as follows:

"This effect was particularly pronounced in vigorous growth, when green manure not only reduced inter-row soil CO_2 emissions but also improved the microclimatic conditions of the tea plantation." (Lines 524-527)

Following the suggestion, we have added the word "significant" to all statements in the manuscript that involve statistical significance, and for cases without significant differences, we only describe the existence of differences.

The explanation of negative CO_2 fluxes is problematic (lines 474–476). Even under low temperature conditions, respiration should approach zero but not become negative unless there are measurement issues or a true sink such as photosynthesis or methanogenesis, neither of which applies here given the dark chamber and oxic conditions. Some interpretations also needs evidence to support, such as attributing increases in CO_2 after pruning to soil temperature needs temperature data to support (line 382). It is also not clear whether differences among green manure types (HM versus SM) are consistently evaluated.

Response: Negative flux values were observed at only a very small number of measurement points, all occurring at 8:00 am during the diurnal measurements in spring. We have checked the data accuracy, and this trend is indeed correct; it does not indicate any measurement issues.

Contrary to the reviewer's perception that negative fluxes are impossible, the chamber method itself can lead to negative values under certain conditions. Studies have shown that although negative soil CO_2 fluxes are uncommon in dark chamber measurements, they can occur under specific circumstances: 1) Microbial carbon pump effects: a portion of CO_2 can be immobilized by soil microorganisms into biomass (though the amount is typically very small). In spring, when soil respiration is low, coupled with environmental disturbances, isolated negative values may appear. 2) In conventional dark chamber measurements, the temperature inside the chamber can be lower than that of the soil surface, increasing CO_2 solubility. When humidity inside the chamber is high (e.g., after rainfall), some CO_2 may dissolve into the water film;

condensation on the inner chamber wall can also lead to CO_2 "absorption" by dissolving in condensed water. Such phenomena can occur in greenhouse gas flux chamber measurements. Every measurement technique has certain limitations, but such minor errors do not invalidate the chamber method. Given that only a very small amount of data showed negative values, and the magnitude of these negative values is extremely small, they have virtually no impact on the overall assessment of emission magnitude. We have explained this in the manuscript in the section on spring diurnal variations.

"In this study, the occasional negative CO_2 fluxes may be attributed to the combined effects of low soil respiration rates under low-temperature conditions in spring, microbial fixation of CO_2, and CO_2 dissolution effects caused by changes in temperature and humidity inside the chamber. These negative values are within the measurement error range and represent small fluctuations that do not affect the assessment of the overall emission magnitude." (Lines 474-479)

There are also several points where the interpretation is not convincing. For example, the discussion of nitrate (lines 577–580) suggests that higher biomass reduces nitrate losses via runoff or leaching, but that does not explain higher NO3- concentrations in soil. These are different processes, and the reasoning does not hold. Similarly, the logic around GHG mitigation, SOC thresholds, and C/N ratios is often unclear or introduced without sufficient context (lines 583–595).

Response: We have made more rigorous revisions.

"Moreover, the NO_3^-–N concentration in the SMG treatment was 14.56 $mg \cdot kg^{-1}$, which was significantly higher than that in other treatments (Fig. 6e). This was because the organic nitrogen input by the high biomass of *Vulpia myuros* C. increased nitrate nitrogen production through mineralization, and its well-developed root system improved soil aeration and inhibited denitrification." (Lines 582-586)

This discussion is a literature review specifically focused on SOC, citing key relevant literature to discuss the impact of SOC changes on soil CO_2 emissions. We did not conduct a confusing discussion on SOC and C/N ratios in this paragraph.

The reported increase in soil C:N ratio from around 10.5 (baseline) to approximately 17 within two years (lines 606–607) is difficult to accept for an established system and needs strong justification.

Response: The reviewer may misunderstand. This study does not present changes in soil properties between the first and second years. The data shown reflect the average values of different green manure treatments and the C:N differences between tea rows and inter-rows. The newly added Table 1 presented the original tea plantation soil data, which were not collected during the first year of the experiment. These data were added in response to Reviewer 2's first-round request to see the initial soil properties of the tea plantation. However, these data were obtained from the tea plantation base database without any experimental treatment; they have no exact measurement date and were not sampled or measured during our experimental period. Consequently, there may be significant differences in data measurement and processing between Table 1 and our experimental data, making direct comparison with our treatment data insufficiently valid. The soil data measured during our experimental period are shown in Figure 6. Therefore, to avoid misunderstanding, we have removed Table 1 from the main text.

In terms of clarity and presentation, many statements need clearer linkage to figures and tables, and statistical significance should be explicitly stated. It is often unclear whether reported values represent means, cumulative emissions, or single time points. Some methodological details are also missing, such as whether chamber bases were kept in the same locations across sampling events and years.

Response: We have already provided detailed explanations in the figure captions and table notes, clarifying the meaning of the data under the respective statistical contexts. The numerical units of mean flux and cumulative emission are inherently distinct, and we have further defined them explicitly throughout the text. Regarding the so-called "single time points", the reviewer may have misunderstood the concept of mean flux. All fluxes presented in this paper are mean fluxes, only differing in temporal scale (e.g., seasonal means, monthly means, hourly means), and we have explained these scales in detail in the corresponding sections of the manuscript.

This study is a long-term in-situ flux monitoring study, meaning that fixed points within each treatment were monitored over a long period, allowing us to reveal the long-term changes in emissions under different green manure treatments. The reviewer's question about whether the chambers were moved is puzzling to us, because monitoring at different locations would render the results incomparable and the approach would be unreasonable.

Some of the conclusions, particularly those related to agronomic benefits and economic implications, feel overstated relative to the data presented (lines 643–645). There are also instances where differences are discussed but appear not to be statistically significant based on the tables.

Response: The reviewer suggested expanding the discussion on agronomic benefits and economic implications during the first round of review, with the aim of increasing the applied guidance depth of the study. However, this study focuses specifically on comparing soil CO_2 emissions from tea plantations under different green manure management practices. We believe that quantifying the emission characteristics of different treatments and providing treatment-specific evaluation recommendations already serves the purpose of advancing low-carbon tea plantation research, as our study did not include economic or policy management data. Therefore, strong inferences on tea plantation management policies would be more appropriately framed as future perspectives. Following the reviewer’s suggestion, we have toned down such inferences in the revised manuscript.

“Meanwhile, the co-benefits of green manure intercropping, such as soil improvement, reduced fertilizer application, and weed suppression, make it a practical and multifunctional strategy for low-carbon tea plantation management.” (Lines 650-653)

There are also specific technical concerns that need attention. In Table 1, SOC appears higher than TC in most treatments, which is not physically consistent and raises concerns about how SOC was calculated. Given that soil pH is below 4.5, it is also unclear whether reporting both TC and SOC is necessary.

Response: The original tea plantation soil data presented in the newly added Table 1 were requested by Reviewer 2 in the first round of review to illustrate the initial soil properties. However, these data were obtained from the tea plantation construction site rather than from soil samples collected and measured during our experimental period. As a result, there may be significant differences in data measurement and processing between Table 1 and our experimental data, making the comparability insufficient and lacking value for direct comparison. Therefore, after comprehensive consideration, we decided to remove Table 1.

The soil data measured during our experimental period are shown in Figure 6. In our measurements, TC was determined as total carbon (including inorganic carbon). However, in the acidic red soil of the study site, the inorganic carbon content is extremely low; thus, TC and SOC should be very close, with SOC being slightly lower than TC. The specific data presented in Figure 6 confirm this pattern.

In Figure 2, graphical elements such as green arrows are missing or misaligned.

Response: Thank you for pointing out this issue. We have carefully checked and revised Figure 2 accordingly.

"Black, red and grey arrows represent the timings of fertilization, grass planting and tea pruning, respectively." (Lines 944-945)

In Figure 3, it is not clear whether there are significant differences in annual CO_2 emissions at the ecosystem level.

Response: This figure presents the significant differences in soil respiration emissions based on a three-way ANOVA with respect to different green manure treatments, spatial positions, and two years. Therefore, different letters indicate significant differences. This explanation has been added to Figure 3.

"Different lowercase letters indicate significant differences ($p < 0.05$) among all treatment combinations (type × spatial position × year) based on three-way ANOVA." (Lines 944-947)

In Figure 6, only a single data point is shown despite monthly sampling, and it is not clear which year the data represent. Overall, the manuscript has substantial conceptual, methodological, and interpretive issues. The central framing around GHG emissions is not supported by the experimental design, and there are multiple inconsistencies throughout the results and discussion. For these reasons, I do not recommend publication in its current form.

Response: Figure 6 presents the average values of soil sampling data from 21 samplings over two years, with 21 soil data points collected for each green manure treatment, in order to demonstrate the significant differences in soil properties under different green manure treatments. We have added a description in the figure caption.

"Each bar is the average of soil sampling data from 21 sampling occasions across the two-year study period." (Lines 962-963)