General

The manuscript is about the effect of a high soil temperature for a certain period on microbial activity ($^{14}CO_2$ from glucose) and microbial carbon use efficiency (^{14}C growth/ ^{14}C uptake).

Response: Firstly, we would like to thank the reviewer for the constructive and detailed feedback that helped us improve our manuscript. Below, Reviewer#1 can find our point-by-point responses, with clarifications, justifications, and, where applicable, modifications in the manuscript.

The hypothesis -I think- is that heat results in a lower CUE, and that balanced nutrient supply or organic amendments decrease the magnitude of the lowering of the CUE.

Response: To clarify, our hypotheses were stated in the Introduction section of the manuscript. They are:

i) bioamendments will increase the availability of P and other nutrients supporting a more resilient soil microbial community with enhanced resistance to extreme heat-stress events than soils receiving mineral fertiliser;

ii) the enhancement of soil heat resistance will then increase or maintain CUE and subsequently soil C retention in soils receiving bioamendments than the mineral P fertiliser; and

iii) the calcareous Vertisol may exhibit greater thermal and chemical buffering capacity under extreme heat events, supporting microbial metabolism at elevated temperatures more effectively than the non-calcareous Inceptisol, due to its higher pH and clay content, which help retain moisture.

We would say that our two first hypothesis are in line with the hypothesis that Reviewer#1 mentioned here.

If CUE is still high at 50 C, the authors assume that the soils has a high resistance to heat. Two soils are tested and three amendments.

Response: We partially disagree here with Reviewer#1. CUE was reduced in both soils at 50 °C in comparison with 20, 30 and 50 °C as can be seen in Figure 2. It happened for all soils except soils treated with composted olive mill pomace, which had the highest microbial CUE

at this temperature (50 °C) in comparison with the rest of treatments (increase in soil resistance to heat).

The type of microbes in the soils were not determined.

Response: Exactly, in this study we focused on nutrient availability in soil, $^{14}CO_2$ emissions and microbial CUE as a function of the soil (Vertisol and Inceptisol) and treatment (control, Diamonium Phosphate-mineral fertiliser and three composted amendments).

Specific comments

The introduction is not always logical, and reading the text still gives many small questions which is unnecessary.

Response: Thanks for this comment. We have deeply modified the Introduction section according to Reviewer#1 comments, including a re-structuration to enhance clarity and logical flow. Several ambiguous phrases and words (e.g., "poor", "negative impact") were also modified. Please, see our responses to the rest of comments related to the Introduction section in the new version of the manuscript.

I wonder if the method is correct. CO2 can be precipitated by Ca and Mg rich materials at certain CO2 concentrations. The vertisols but also the composts probably contain carbonates. Should this be tested with a dead soil?

Response: Although we understand Reviewer#1 concern, this method is commonly used with soils containing carbonates to the effect of different evaluate edaphoclimatic conditions and fertilisation strategies on soil microbial CUE. In addition, Strom et al., in the study "Procedure for Determining the Biodegradation of Radiolabeled Substrates in a Calcareous Soil" https://doi.org/10.2136/sssaj2001.652347x indicated that some CO_2 fixation could indeed be fixed by $CaCO_3$, but it only happens in soils that are very carbonitic (>20% $CaCO_3$ by weight). In our study, some CO_2 fixation could occur in our Vertisol, however, the trends will all still be relative to the control.

Some references in which this method was used with calcareous soils and with soils that have a considerable content in carbonates are listed here:

Jones, D.L., Olivera-Ardid, S., Klumpp, E., Knief, C., Hill, P.W., Lehndorff, E., Bol, R., 2018. Moisture activation and carbon use efficiency of soil microbial communities along an aridity

gradient in the Atacama Desert. Soil Biology and Biochemistry 117, 68–71. https://doi.org/10.1016/j.soilbio.2017.10.026

Sánchez-Rodríguez, A.R., del Campillo, M.C., Torrent, J., Cooledge, E.C., Chadwick, D.R., Jones, D.L., 2024. Phosphorus fertilization promotes carbon cycling and negatively affects microbial carbon use efficiency in agricultural soils: Laboratory incubation experiments. Geoderma 450, 117038. https://doi.org/10.1016/j.geoderma.2024.117038

Sánchez-Rodríguez, A.R., Del Campillo, M.C., Torrent, J., Jones, D.L., 2014. Organic acids alleviate iron chlorosis in chickpea grown on two p-fertilized soils. J. Soil Sci. Plant Nutr. 35–46. https://doi.org/10.4067/S0718-95162014005000024

Finally, we have not tested the bioamendments with dead soil (autoclaved soil) because we wanted to develop the experiments under more realistic conditions. For that reason, we did not sterilise the soils used in our experiments.

For readers not familiar with CUE, the calculation should be given. I

Response: Following these comments from Reviewer#1, we have modified the Material and Methods section as follows, including some references:

"Microbial immobilisation of the 14C-substrate ($^{14}C_{imm}$) after 27 days was estimated as follows:

$$^{14}C_{imm} = {}^{14}C_{tot} - {}^{14}C_{NaCl} - {}^{14}CO_{0–27\ days} \quad (1)$$

where $^{14}C_{tot}$ is the total amount of ^{14}C-substrate added to the soil at time (t) = 0, $^{14}C_{NaCl}$ is the amount of ^{14}C recovered from the soil in the 1 M NaCl extracts at the end of the experiments and $_{14}CO_{0–27\ days}$ is the total amount of ^{14}C recovered as $^{14}CO_2$ during the experiments. Following Jones et al. (2018a,b), microbial CUE for the C substrate was then estimated as follows:

$$CUE = {}^{14}C_{imm} / ({}^{14}C_{imm} + {}^{14}CO_{0–27\ days}) \quad (2)$$

Is it relevant that the microbial life has not been determined?

Response: We agree with Reviewer#1 here that the evaluation of soil microbial biomass could be interesting for understanding to correlate the changes observed in our study with soil microbial structure. However, our main concern in this study was to determine and highlight the positive effect that could have some of the tested bioamendments on soil heat resistance

and microbial CUE, regardless of the type of microorganisms. However, we will keep that comment in mind for future work.

Minor comments

Title: I guess "resistance" is an interpretation of the CUE at various circumstances. So the title should be more like …..resistance derived from microbial CUE measurements…

Response: We appreciate your suggestions; the title was modified as follows:

"Do composted bioamendments enhance Mediterranean agricultural soils resistance derived from microbial carbon use efficiency measurements to extreme heat-stress events?"

Writing only about western Mediterranean region is strange, it also seems relevant for other regions in the world.

Response: We totally agree with Reviewer#1 here, this work could be very useful for other areas with similar conditions. We have modified this part to suit more regions with similar soil and climate conditions:

"Summer temperatures in regions with Mediterranean semi-arid climate has reached high records and are expected to become more intense over the next few decades (Tejedor et al., 2024). The increase of global warming affects soil microorganisms and their activity in this region (Bañeras et al., 2022; Bérard et al., 2011), which involves changes in their structure and functioning, hence, altering nutrient cycling at a regional and global scale (Frey et al., 2013; Mooshammer et al., 2017; Reichstein et al., 2013)."

53-53. This does not seem relevant for this manuscript.

Response: Thank you for your observation. We have removed it to improve clearness of the Introduction.

59 "poor" suggests that you have a opinion, which is strange if it is a natural state. I guess you mean low.

Response: "Poor" was deleted according to this suggestion and "Low" was used in this occasion.

61"negative impact", similar comment. Being calcareous is a state, it is not intervention which has an impact: it is the just the state of these soils which is problematic for certain crops.

Line 61: Thanks for that, “negative impact” was removed and we used “which may constrain plant productivity” instead.

59-63 I do not agree with the statement: “…. that calcareous soil … often lead to a negative impact on soil fertility and plant productivity”. Impact is a strange word for a state of a soil, but also the idea that calcareous soils give low plant productivity is not correct: there is potential for negative effects. However, the productivity of calcareous soils is high when sufficient water and nutrient are applied (as is true for most soils). Maybe you mean alkaline soils, or the vertisols, when you want to talk about problematic soils.

Response: We agree with Reviewer#1, we re-wrote the paragraph to be more precise:

“Calcareous soils are common in these areas, and they associated with limited availability of certain nutrients (e.g., P, Zn, Fe), which may constrain plant productivity under specific conditions”

63 50 degrees Celsius is not that high for a barren dry arable soil. On a global scale many parts of the land have higher temperatures than air temperature. https://doi.org/10.1029/2010JG001486

Response: We appreciate this observation and agree that surface soil temperatures under direct solar radiation in dry, exposed environments can indeed exceed 50 °C, often significantly higher than ambient air temperatures. We have modified this part of the Introduction section accordingly and included this useful reference:

“In addition, surface soil temperatures in arid dry agricultural fields often surpass air temperatures in such regions, and soil temperature exceeds 50 °C during extreme heat events, especially under intense solar radiation and low moisture conditions, which are common in semi-arid Mediterranean climates (Hamdi et al., 2011; Perkins, 2015; Vogel et al., 2017, Mildrexler et al., 2011).”

70 Many authors have studied organic matter mineralisation, for example Kirby et al. showed an effect of nutrient on CO2 loss in a incubation experiment. https://doi.org/10.1016/j.soilbio.2013.09.032. In this paper the focus is on CUE. Please introduce this specific aspect. Why is it better or different?

Line 70: Thanks Reviewer#1 for the valuable suggestions, modifications were done here to include this mentioned study:

"Microbial CUE is defined as the proportion of carbon taken up by microbes that is dedicated to growth rather than lost as CO_2 via soil respiration. It is a central determinant of soil carbon retention, and, therefore, a more meaningful indicator of microbial functioning and soil carbon dynamics than respiration alone (Allison et al., 2010; Ghee et al., 2013; Li et al., 2019; Mganga et al., 2022). According to Kirby et al., (2014), soil carbon sequestration and CO_2 released by soil microbes are directly affected by soil nutrients content. Other studies indicated that microbial CUE strongly influences soil C sequestration and is sensitive to various biotic (e.g., competition between species) and abiotic (e.g., pH, temperature) factors (Iven et al., 2023; Jones et al., 2019). This motivates research to identify which management strategies may enhance the resilience of semi-arid Mediterranean soils to extreme heat-stress events (> 40 °C) to prevent widespread soil degradation (Ferreira et al., 2022)."

77 "most", do you mean "these"? Or do you mean other studies, then you should mention the other studies.

Response: Expression modified (now we used "these studies" as we mentioned two studies here). Thanks.

78-79 "such as calcareous soil … in regions?" Why not directly mention that vertisols and alfisols are specifically challenging?

Response: Thanks for the appreciation, but we do not want to focus only on Vertisols and Inceptisols here, in this part of the Introduction, as other soil orders, Alfisols and Entisols, are also important in these regions. In the objectives, we focused on Vertisols and Inceptisols and explain the reasons why we chose them.

81 and 84 "such as available P, further potentially deceasing CUE……23-24% reduction in CUE due to DAP and SSP.." Both sentences do not agree with each other. Does additional P increase or decrease CUE or do you mean that it is probably more complex?

Response: Many thanks for your comment, we agree that this part of the Introduction was confusing. We would like to mention that CUE is negatively affected by the addition of mineral P fertilisers, according to previous research (by Sánchez-Rodríguez et al., 2024) and that, oppositely, Su et al. (2025) stated that CUE increased with the addition of organic fertilisers at

the same time as increased P availability to illustrate the need for more research in this topic. This shows the complexity of the relationship between P application to the soil and CUE as Reviewer#1 mentions. We have rewritten this part of the Introduction section to improve clarity and precision:

"While P is essential for microbial growth, inorganic P fertilisers reduced microbial CUE in the short-term, as stated by Sánchez-Rodríguez et al. (2024). They found a significant reduction in microbial CUE (23-24%) in typical Mediterranean soils (Inceptisol, Alfisol, and Vertisol) when P was applied to the soil as diammonium phosphate or single superphosphate, which may be due to shifts in microbial community and nutrient dynamics or stoichiometric imbalances. However, Su et al. (2025) stated that the addition of organic fertilisers significantly enhanced CUE at the same time as increased P availability. These studies are fundamental to design sustainable strategies in which the adoption of organic agriculture practices, such as compost application, to obtain more resilient farming systems (Moreno-Pérez, 2023) in line with European policies and strategies (Rato-Nunes et al., 2017). However, the effects on microbial CUE after the application of organic amendments under extreme heat stress is still not clear."

97 "little is known about their impact on CUE" Is that true, not at a first glance. https://doi.org/10.1186/s13213-024-01780-9, https://doi.org/10.1007/s42832-022-0137-3, https://doi.org/10.7717/peerj.12131, https://doi.org/10.1016/j.soilbio.2024.109531. So, please be more precise.

Response: Thanks for the references. We agree with Reviewer#1, previous research has deal with the impact of extreme heat on soil microbial CUE. However, there is not much work on microbial CUE and organic amendments under heat stress in soils from Mediterranean regions. We revised the stated section to suit better the idea and to specify the knowledge gap that we are working on:

"Although previous research has evaluated microbial CUE under extreme heat scenarios (e.g., Dang et al., 2024; Zhang et al., 2022, Adingo et al., 2021), there is a critical knowledge gap in evaluating the impact of bioamendments application to the soil on microbial CUE under severe climatic conditions as extreme heat waves, such as those documented in Mediterranean areas. This information is needed to design holistic strategies that include the use and potential benefits of bioamendments in Mediterranean regions with challenging soil properties (low organic matter content and reduced availability of P) that are subjected to extreme heat-stress events."

103 Earlier you mentioned that the calcareous soils were problematic for phosphorous, and now you include a non-calcareous soil. Please explain you choices: for example you chose soils with a low P availability.

Line 103: Effectively, both soils have a low content in P. However, the choice of the calcareous soil (Vertisol) was for its content in carbonate, which limits nutrients availability for plants, and also this type of soil is typical in the area of the study that normally suffers from successive and continuous heat stress. The Inceptisol is other typical soil in the area of the study with low P availability too. The use of these soils helps us have an idea on the behaviour of soil microorganisms (CO_2 respiration and microbial CUE) of these two contrasting soils (calcareous and no calcareous soils) under heat stress with the application of different bioamendments.

We have clarified the idea behind the decision of using the mentioned soils on the manuscript:

"This study investigated the effects of various bioamendments (composted olive mill pomace, composted biosolids, and composted solid urban residue) and a mineral fertiliser (diammonium phosphate) on microbial CUE and key soil chemical properties (including available phosphorus, carbon, nitrogen, pH) in a calcareous Vertisol and a non-calcareous Inceptisol, both collected from Mediterranean regions and with a low P availability. These two soils exhibit contrasting carbonate and clay contents, enabling the assessment of whether calcareous soils buffer the effects of extreme heat stress, and the role of added bioamendments in increasing their resistance."

104 "soil biogeochemistry". Please write more precise: you do not study soil biogeochemistry, you have determined P-Olsen and extractable N.

Line 104: We appreciate this comment. Please, see our response to the previous comment as the modifications are included there.

106 "than conventional fertiliser". This does not seem a fair comparison. If so, then you should add similar amount of nutrients using various mineral fertilisers, including micronutrient. Conventional fertiliser is not a very good term: in many countries this is animal manure, in other mineral fertiliser. So mineral fertiliser is a better term. In most studies authors use a simple fertilisation advice for the soils, and choosing different fertilisers. In the current research you might have deficiencies for N, Mg, S etc. By using

soils from farms, you probably use well fertilised soils, without deficiencies, at least not in micronutrients.

Line 106: We appreciate this suggestion done by Reviewer#1. "Conventional fertiliser" has been modified by "mineral fertiliser" through all the manuscript to increase clarity. Thank you for this insightful comment. Regarding the comparison between mineral fertiliser (diammonium phosphate) and bioamendments: we agree that a direct comparison is only meaningful when both are applied with the same agronomic objective, in this case, enhancing phosphorus availability. In our study, all treatments were applied at rational rates that reflect typical field practices aimed at improving soil P availability (but not the rest of elements). Under this framework, the comparison can be considered fair, as both the mineral fertiliser and bioamendments were used to serve the same function in the short-term (increasing soil P by introducing equal amounts of P by all the used treatments, mineral fertiliser or bioamendments), and the results reflect the relative efficacy of these treatments under the same experimental conditions.

108 "a more buffered". This is in contrast to line 79 were you state that the vertisols are prone to high moisture and reduced oxygen.

Line 108: Thank you for your observation. We agree that the phrasing may have caused confusion. The statement referring to Vertisols as "*more buffered*" was meant to describe their thermal and pH buffering capacity, due to their high clay and carbonate content, rather than suggesting they are universally buffered against all environmental stresses. In contrast, the earlier mention highlights that Vertisols are prone to poor drainage, which can lead to high moisture content and low oxygen availability, particularly under wet conditions. These characteristics can indeed reduce microbial CUE under certain circumstances.

We have revised the text to clarify the specific buffering properties being referred to and to avoid generalizations that may imply inconsistency.

145-150 Did you make batches of soil+amendment mixtures, and did you sample these mixtures for experiment 1-3? The text does not explain how you did this. This is relevant as these amendments have a structure (compost contain large particles, and the phosphate minerals are also particles). If you sample 2,5 gram soil (mixture of soil+amendment), then the samples are probably heterogeneous. This might explain the large variance in figure 2. Also in figure 3 there is a large variation for soluble N in the

treatment with DAP although in every soil you have added the same amount of N+P. It is rather problematic that the variation is so large, when you expect very similar results.

Lines 145-150: We thank Reviewer#1 for this important observation. We have now clarified in the Methods section that soil and amendment mixtures were thoroughly homogenized before subsampling, and that all replicates were prepared identically. The higher variability in soluble N in DAP-treated soils could be due to the small amount of this fertiliser added to each soil sample (the smallest considering all the treatments as its P concentration was the highest); however, although a high variability was observed with DAP in extractable total N, this treatment produced the highest values of this variable.

We add the modifications done in this part of Material and Methods as follows:

"To ensure representative amendment application, larger bulk mixtures of soil and treatments than needed were prepared. Previously, the fertiliser and the bioamendments were ground and sieved to 0.5 mm to ensure homogeneity. The required amount of fertiliser or bioamendment needed to reach the target P level of 50 mg kg^{-1} in 2.5 g of soil was extremely small and technically challenging to apply accurately. Therefore, soil was gradually added to pre-weighed fertiliser or bioamendment in larger batches, followed by thorough mixing to ensure homogeneity. From each homogenised batch, subsamples of each mixture (fertiliser / bioamendment and soil) were used for incubation experiments. The obtained mixtures were wetted as explained in each experiment to ca. 0.18 g g-1 gravimetric moisture content (43 and 49 % water-filled pore space for the Vertisol and the Inceptisol, respectively) to activate soil microorganisms and reflect the relatively dry conditions typical of Mediterranean topsoil during summer heatwaves."

150 It seems like a small amount of water: 0.18 gram water per gram dry material? Normally soils are wetted until a certain percentage of water filled pore space: ±70% of the maximum, to have a good circumstances for plant roots.

Line 150: many thanks for your comment. The amount of water added to our soils (gravimetric moisture of 0.18 g g^{-1}; 0.45 g per 2.5 g of soil) corresponds to approximately 43-49% of the water-filled pore space for the Vertisol and the Inceptisol, respectively. This moisture level was selected to maintain microbial activity, prevent anaerobic conditions during incubation, and reflect the conditions typical of Mediterranean topsoil when P fertiliser of bioamendments are applied. We wanted to simulate the conditions that can be found in these soils when the P

fertilisers or bioamendments are added to the soil before sowing cereal (durum wheat, typical in this region).

190 Soils seem deficient in zinc according to these measurements.

Line 190: Indeed, both soils are deficient in Zn. This is normal in some soils collected from Mediterranean areas. In this case, we think this is not important for our study as we are focused on soil respiration and CUE under the conditions that are common in these soils just when the P fertilizer or bioamendments are applied and not in plants (critical soil Zn values are calculated as indicators for plants).

197 data in table 2 are strange for "volatile solid content" or "oxidable organic carbon". How is it possible that the volatile solid content (proxi for organic matter, and water to clays) is lower than organic carbon? You would expect a factor 2 between both.

Line 197 : Thank you very much for pointing this out, after reviewing the data and doing new measurements, we confirmed that there was a mistake in the oxidizable carbon values reported in Table 2. Specifically, a data entry error occurred during formatting, leading to incorrect values that did not reflect the actual measurements. We have now corrected the values, which are consistent with expectations. This correction does not affect the interpretation of our results or conclusions, as the trends remain unchanged. The updated values and clarification of units have been incorporated in the revised Table 2 and its text.

200 Can $^{14}CO2$ might also be precipitated as CaCO3? For example:. https://doi.org/10.1016/S0168-1923(02)00231-9. So how sure are you of the measurements? Has it been tested in dead soil?

Response: Firstly, we replied to this question in a more general way in "Specific comments, I wonder if the method is correct. CO2 can be precipitated by Ca and Mg rich materials at certain CO2 concentrations. The vertisols but also the composts probably contain carbonates. Should this be tested with a dead soil?" Please, read our pecious response.

Additionally, we added some references of studies in which microbial CUE was calculated in calcareous soils, and this method was useful to understand the reactions occurring in these soils in relation with C and nutrient dynamics in soil.

In this study, we did not use sterile (dead) soils as a control. Our experimental design aimed to simulate realistic conditions, including the native microbial communities of each soil type to

assess how bioamendments affect microbial carbon use efficiency (CUE) under heat stress. Given the one-week incubation period, we expected microbial activity to remain stable making the use of sterile soils less representative of real conditions.
We acknowledge, however, that $^{14}CO_2$ precipitation as $CaCO_3$ is a potential limitation, particularly in calcareous soils. While no significant anomalies were observed in comparison to the more acidic Inceptisol, we recognize the need for further studies using sterilized controls to directly quantify CO_2 precipitation and improve CUE estimations in carbonate-rich soils. This point has been added to the discussion as a methodological limitation in the section 4.2 "*Wider implications and priorities for future research*":

"Furthermore, we recognize a potential methodological limitation related to the use of ^{14}C-labelled glucose to calculate microbial CUE in calcareous soils. Specifically, the potential precipitation of $^{14}CO_2$ as $CaCO_3$ may have led to an underestimation of CO_2 emissions from soil and overestimation of CUE. While no major anomalies were observed between the calcareous and the non-calcareous soil, future studies should consider including sterilised soil controls to assess this effect more accurately and enhance the robustness of CUE calculations in carbonate-rich systems."

209, 238, 250: Experiment 1, 2 and 3 have been performed in different tubes:

1: 2.5 gram soil, 0.2 ml water, 50 ml tube, 0.25 ml labelled glucose.

2: 2.5 gram soil, 0.2 ml water, in a 1,5 ml (?) Eppendorf tube. How does this fit?

3:2.5 gram soil, 0.2 ml water in 50 ml tube, 0.25 ml labelled glucose.

Unclear are the effects of the differences. Unclear: are the tubes closed from air, or open? Does the soil dry out during the 27 days of having a 1 M NaOH trap on top of it?

I would not use the word "soil" here, when you mean a mixture of soil+amendment. A reader expects that you add the amendment afterwards when he/she reads "soil".

Response: We appreciate this comment. The used flask volume has been corrected in the second experiment. It was the same volume for the three experiments as Reviewer#1 pointed out. The modifications were done only in the second experiment (2.5.2), as follows:

"To determine changes in chemical characteristics in soil receiving bioamendments or inorganic fertiliser after an extreme heat stress event, other experiment was built in parallel to Experiment 1, with 2.5 g of soil (n = 3 per treatment, soil type and temperature) placed in a 50

ml polypropylene centrifuge tube, rewetted with 200 µl of DI H_2O, and pre-incubated at 20 °C for 1 week."

Concerning the Falcon tubes, they were hermetically closed during the experiment as mentioned. This prevent or minimises soil drying:

"A 6 ml polypropylene vial containing 1 ml of 1 M NaOH was then placed above the soil surface to capture respired $^{14}CO^2$ and the tubes sealed".

Finally, in each subsection (2.5.1, 2.5.2 and 2.5.3) we have used "soil or soil and fertiliser or amendment mixture" according to Reviewer#1 comment.

2.5.2: In experiment 2: pH, mineral N, and P Olsen were determined. Did you do this on this small 2.5 gram sample? How?

Rather unclear how you derive CUE.

Response: Yes, we did all the analysis with 2.5 g of soil. We have slightly modified this section to include that information:

"Then, soil pH and EC were determined on 0.5 g of fresh soil or soil and fertiliser or amendment mixture following a 1:2.5 w/v (soil:solution) DI H_2O extraction using micro-pH meter and micro-conductivity meter. Gravimetric soil moisture content was determined by drying 0.5 g of soil at 105 °C for 24 h. Total extractable N and organic C were analysed on 0.5 g of soil using 0.5 M K_2SO_4 extracts (1:5 w/v) on a Multi N/C 2100 S analyser (AnalytikJena, Jena, Germany). Soil ammonium (NH_4^+), nitrate (NO_3^-), were measured colorimetrically from the 0.5 M K_2SO_4 extracts using the methods described in Mulvaney (1996) and Miranda et al. (2001), respectively. Available phosphorus (Olsen-P) was determined on 1 g of soil, using the method of Olsen et al. (1954) as described previously."

263-275 Please give calculation of CUE in the methods.

Response: Done. The Material and methods section includes the equation and two references of the method as previously mentioned in "Specific comments". We do not add the same information here to avoid repetition.

357-364 So nitrification is rather slow. One would expect that all NH4 would be transformed into NO3 after so many days, at least for DAP.

Response: We agree with Reviewer#1. Nitrification was slow. that under optimal conditions, NH_4^+ from DAP is generally expected to be nitrified to NO_3^- over a period of several days. Different limitations could have occurred:

(i) High incubation temperatures (40 °C but especially 50 °C in the Vertisol) likely inhibited the activity of nitrifying microorganisms, which are known to be heat-sensitive and function optimally below 35-40 °C.

(ii) The relatively short incubation period (9 days) may not have allowed complete nitrification to occur under the conditions of the experiments.

425 "not many", if so then you should mention these few studies.

Response: Corrected to mention that there are not studies:

"Moreover, there is a lack of studies that evaluate the role of soil type and different amendments in buffering the negative effect of extreme heat events on CUE, especially, when soils are exposed to extreme heat stress where air temperatures exceed 40 °C…"

440 Do you add microbial live to a sample by adding compost? Or is that negligible to soil?

Response: Yes, microbial life is added when compost is applied to the soil, and the microbial community of the soil could be modified. However, the assessment of the effect on microbial CUE after compost application under different temperatures (including extreme temperatures) is the aim of the study.

445 Strange. You Spanish soils have of course been adapted to 50°C. You have given the temperatures, and temperatures of soils are often much higher than air temperatures. Otherwise you should have chosen soils from Scandinavia or some other region without warm summers/sun.

Response: We agree with Reviewer#1; topsoil temperatures often exceed air temperatures, particularly under direct solar radiation in arid and semi-arid environments. However, in our study, we included a range of temperatures to evaluate the potential shift in microbial CO_2 release from the soil and microbial CUE in these soils (that occurred at 50 °C in both soils). So, we could say that our soil microbial communities (in the vertisol and the inceptisol used here) are resistant to temperatures up to 40 °C but a dramatical decrease in microbial CUE occurred at 50 °C, except when composted olive mill pomace was added to these soils (when

the decrease in microbial CUE was not as evident as in the other treatments, including control, DAP and other bioamendments).

498 "…. Especially DAP, lead to … NH4… this reflects either increased mineralization of organic N or….". That seems to make no sense. You add NH4 with DAP (NH4 and HPO4), so you do not need a biological process to find NH4.

Response: We have improved this phrase as we agree with Reviewer#1:

"According to previous research (Dai et al., 2020), the application of fertilisers, especially diammonium phosphate, leads to a greater accumulation of NH_4^+ (Fig. S5) and dissolved TN due to the high amount of NH_4^+ that this fertiliser provides to the soil."

528 "vulnerability". I wonder if you can state this on the basis of your two soils

Response: "Done:

"This study highlights the vulnerability of Vertisols and Inceptisols located in semi-arid regions to extreme heat-stress events."

570-575. That is a rather unrealistic conclusion: the availability of compost per hectare in the EU is very small compared to potential need. It is probably much easier to keep the soil covered with crops, being cover crops or crops.

Response: We partially agree here with reviewer#1. The conclusions drawn in this study are based specifically on the observed effects of a set of bioamendments that are commonly used in agriculture Southern Europe. Since the study did not include any specific cropping systems or crop cover strategies, we agree that it is not possible to make broader comparisons between bioamendment application and alternative approaches such as maintaining permanent soil cover. We acknowledge that future research would benefit from directly comparing the effectiveness of different soil management strategies, such as bioamendment application versus cover cropping, in enhancing soil resilience to heat stress; and we agree with Reviewer#1 in that cover crops could be a potential option for these vulnerable soils to extreme heat events located in Mediterranean regions.