General comments:

The manuscript needs to be sharpened in all parts.

The results shown differ from what is described in the discussion, the interpretation of the results is often about why the data did not show certain expected patterns when it should be about what their data actually did show. In the current form, I would not recommend publication. The manuscript needs a bit more than major revisions and my suggestions are below.

Scientific significance: 3-4

Scientific quality: 2

Presentation quality: 3

1. **Does the paper address relevant scientific questions within the scope of SOIL?**

   Yes it does. It addresses drought x compost effects on plant growth and parameters relevant for evaluation of soil carbon development.

2. **Does the paper present novel concepts, ideas, tools, or data?**

   It presents new data on drougt x compost effects in grasslands

3. **Does the paper address soils within a multidisciplinary context?**

   Yes.

4. **Is the paper of broad international interest?**

   Generally, the topic itself is of international interest.

5. **Are clear objectives and/or hypotheses put forward?**

   Yes.

6. **Are the scientific methods valid and clear outlined to be reproduced?**

   Yes.

7. **Is the soil type/classification adequately described?**

   No, not yet.

8. **Are analyses and assumptions valid?**

   Yes.

9. **Are the presented results sufficient to support the interpretations and associated discussion?**

   Not always, especially the interpretations on the microbial community and it was not explained how plant community structure was assessed. Often, the results shown and the discussion/interpretation differs. E.g. in the discussion they say there was shift of C allocation in plants towards roots while a) not measuring C content of the roots and b) no change in root biomass is seen in the results. This happened regularly, especially in the conclusions.

10. **Is the discussion relevant and backed up?**

Yes and no. There are relevant parts, there are parts that can be cut and there are parts that do not match the data (as described above)

11. Are accurate conclusions reached based on the presented results and discussion?

No. The conclusions and parts of the discussion do not match the results.

12. Do the authors give proper credit to related and relevant work and clearly indicate their own original contribution?

Yes.

13. Does the title clearly reflect the contents of the paper and is it informative?

No. The reason is named below.

14. Does the abstract provide a concise and complete summary, including quantitative results?

No, not yet but can be achieved.

15. Is the overall presentation well structured?

Yes.

16. Is the paper written concisely and to the point?

Can be improved, see my comments below.

17. Is the language fluent, precise, and grammatically correct?

Mostly yes.

18. Are the figures and tables useful and all necessary?

Yes. Sometimes, a figure mentioned in the text is wrongly numbered.

19. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used according to the author guidelines?

Yes.

20. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

Yes, see my comments below.

21. Are the number and quality of references appropriate?

Not yet, this can be improved.

22. Is the amount and quality of supplementary material appropriate and of added value?

Yes, but in the methods part, it is not described how macronutrients e.g. Mg or P have been measured thus, there is value lost.

Major comments:

The title is misleading. The main topic of the text is about compost and drought effects. The spatial and temporal variability in soil and vegetation is only mentioned a few times and the hypothesis also focus on the compost and drought effects.

Abstract:

L9: grassland soils have no large C sequestration potential, only a change of management from arable land to grassland has this C sequestration potential. Grassland itself not. Grassland it self is either in a C equilibrium if it is a grassland for long enough or C accrual may happen which may sequester C depending on how this accrual is achieved. Only a global net increase in C is sequestration, otherwise if e.g. compost is used, the C contained in this composed is merely moved from site 1 to site 2 and does not achieve a net uptake of C from the atmosphere into the soil.

L14: Vegetation C pools are not shown. Biomass is shown.

L14-15: Too fuzzy. You could say that in the compost addition treatment you found higher aboveground biomass. There is a correlation, but you did not prove the causation. Also increased compared to what? The control? Mention this to be clear.

L16: decreased it only compared to compost treatment. Compared to the control nothing happened.

L17-18. Not true based on your data. Soil amendment shifted C allocation upwards as shoot biomass increased, yes. But drought had no effect on belowground biomass. Only the type of roots was affected, not the biomass. Thus, drought had no C shift as a consequence.

L21: Nowhere, in the complete manuscript do you talk about upscaling. This part needs to be cut

Introduction:

L31: "…mitigate soil organic carbon loss…" I would add here that this is the case locally. E.g. mitigate soil organic carbon loss on a specific site. This is relevant, as leakage needs to be taken into account as all amendments are basically biomass from another site, transformed and then brought to the specific site where you want to amend this biomass. You export biomass from site A, reducing C inputs there, and import it to site B, increasing C there. Also, leakage should then be explained to the readers, so they can follow. This matters as this is the major limitation to such amendments. It needs to be additional biomass globally, not locally, to enable C sequestration in soils by increasing SOC accrual.

L86: The text before does not highlight enough the time scales of SOC formation. Sometimes you refer to land use history which indirectly shows that the effects are decadal up to centennial and more. However, then you conduct three year experiment to search for SOC stock changes which is a very short time for C stabilization experiments. This needs to be mentioned in the discussion the latest. Of course, you find an increase in SOC, as you add C rich material. This is not surprising. But how much of this would be left after 10 years, especially of a one time only amendment which is also not the agricultural reality. This is a drawback of the study that needs to be discussed in the discussion part which it currently is not.

L81-89: This belongs partially in the methods and in the results part and not in the introduction.

L23-90: The introduction in general, needs to be more focused. You start with general topics, good. Then you need to narrow everything down to the question: Why do we need to study organic

amendments more? Show clearly the knowledge gaps and show ways to answer these. These ways will be your hypothesis. This link needs to be clearer (I address this in the specific comments section). In the end, when the readers read your introduction, they need to be able to not only follow your content but also to reach the same conclusion about why does your topic matter and how to fill the knowledge gaps. As of now this is too weak and not focussed enough. When I read your hypothesis, I wonder why you look at organic amendments and not mineral amendments or other management practices. It still seems a little bit "random". With a little bit of work, this can be changed and improve the overall quality of the paper.

L91-94: Hypothesis 1: How does compost increase plant growth? Make the mechanism clearer in the introduction (line 58 needs more information on this for the readers to follow). Also, how does compost increase soil C? You did not state that compost is an organic amendment and you did not state that organic amendments are having high C content. Needs to be added in the introduction. L37 states this indirectly which is too fuzzy. Make this connection clearer by explaining e.g. how compost is made and its properties. Then this part of the hypothesis becomes very easy to follow. It remains also too fuzzy how a decrease in bulk density causes a negative effect on C stocks. Everything up to here is known and not suitable for a hypothesis, the real hypothesis follows now "we expect that these mechanisms have counteracting effects on net soil C storage;" This hypothesis is not clear and too fuzzy. Which is the direction of the effect you expect based on the introduction part? Do you expect the positive effect to be stronger or the negative one? This would make for a great hypothesis.

L94-95: I recommend to turn this around to be clearer in your communication: Drought will have a weak or non-detectable effect on SOC by decreasing both productivity (organic C input) and respiration (microbial decomposition of SOM). In addition: as for hypothesis 1 it is not entirely clear why you study drought effects. You need to stress this more in the introduction as you address there rather the need for SOC increases to improve soil health and that this could happen via amendments. The climate effect is only mentioned in 1 line or so. Stress this point, as it is highly relevant! Furthermore, be more precise. Will drought have an effect or not? If yes, in which direction do you expect it based on what should be contained in the introduction?

Methods:
L132-135: Too fuzzy. What the auger 15cm long and you took the 1st sample 0-15cm. Then you used the same hole for the next 15cm (15-30)and then the same hole for 30-45cm? Please specify how you did it. Also, in case you used the same hole and the auger was 15cm (and not 45cm) long: Do you not think, that the insertion of the 15cm long auger compacts the soil below 15cm and thus you would get much denser samples for 15-30 and 30-45cm?

L137-138: In what kind of increments or is this a bulk sample from 0-100cm? Please add.

L140: Was this measured pH the actual or the potential pH? Was measured in destilled water or CaCl2? Please add.

L147: How did you place the auger? On the plants, in between plants? This will be changing the results strongly, so please be more specific on how you did this.

L148: Why do you sample all plots to 30 cm and then just a subset of 16plots to 45cm? Which were the 16 plots? Which plots and why were they not sampled to 45cm? Please be clearer on this.

L157: How did you calculate the stocks? Explain and state which factors you included. Did you consider the packing density? For this, see publications of Poeplau et al, which you already cited for the d13C calculations. He explains how to calculate stock correctly.

L168-170: What do you mean by "This is because this soil depth contains the majority of […] the microbiological activity […]" What is a majority of activity? How did you measure this? You have not explained anything about microbiological measurements so I wonder how you could back you sentence up by data. Please adjust.

L174: what was you alpha? 0.05, 0.01? Please add.

Results:

L211: Figure 1 does not include the effect of the drought treatments. It would be nice to see them too in a similar figure, especially, as the text above L205-209 does not read well and takes some time to see in which treatment the C derived from compost is higher.

L232: Figure 2: Why is the 0-5cm box always yellow? Not explained. If there is no reason, I'd suggest to remove this background colour. Problematic is also that there is a dot in the box-plots for the mean value but the points outside the box-plots are outliers. If possible, adjust this to two different symbols.

The caption needs to be adjusted: there are no bars, these are called box plots or Box-Whisker-Plots. Please adjust this. Also explain in the caption what C is. Figures must be self-explanatory without the main text. So, the reader needs to learn again that C = carbon

L263: Figure 3 similar to above. The yellow background, the C=carbon, the inside and outside dots. In addition, the sampling depths need to be named in the caption. What does "low" and "high" in the sites name mean? Too fuzzy, I assume it is the upslope and downslope area? In the text you usually call higher position in the catena (or similar), therefore, keep it consistent and call it here the same.

L280: Figure 4: comments as above. In addition: Be more specific as you state (excluding treatment plots). Better write Values of X and Y …..in 2022 of all control plots. Also give us an n= ? How many control plots are meant? This should be a standalone figure. This n in addition, should be also added for all figures above. This helps the reader to understand the values better as it matters if those values are derived from 3 plots or from 100.

L185 Tabe1: orange and red are hard to distinguish. Also, people with a red-green weakness could not see any difference in colour. Depth with a capital D, Factor with F to keep the table headings consistent. Differences: Add the p value for that. This needs to be a stand alone table. Where do I see the sites names? In the figure before the sites had names, here not. Keep it consistent. Why are the horizontal lines around "year" thicker than all others? If I read catenary position as factor, by just looking at this table and nothing else, I do not know which positions you had, same for all other factors. Name these.

Discussion:

The whole discussion needs to be checked if all statements about the results mentioned here, are actually found in the results. Comments on this will follow here.

L297: The effect of compost after the few applications is indeed expected to be hardly detectable. Here you could add results from long-term experiments showing after what time a significant change is to be expected.

L301-302: This conclusion is not entirely correct. It may be part of the reason, surely the climate of the growing season differed as well to have an effect. For the suspected increase in N (which you did

not measure) I suggest to add a reference showing this. In these lines be a bit more careful, as compost is one of multiple reasons why the biomass is be increased as you cannot prove that it was the compost treatment alone.

L302-305. Cut into two sentences to improve understanding. Also, what do you mean that compost application "was manifested as extended growing season"? I cannot follow the interpretations here.

L321: This is no C sequestration. This is C accrual. C sequestration in soils is always a global net increase. Compost is biomass exported from another area of land and imported on this plot. That entails a C loss in site 1 and an increase in site 2. Thus, just a shift of global stocks, not an increase. This is important as currently the discussion about the possibility of agriculture to offset GHG emissions is heated and lots of impossible hopes are there. Therefore, I strongly suggest in order to keep the communication clear, do not call compost amendments a C sequestration measure or similar. This is merely a management option to shift C from one site to another to improve soil health. C sequestration however is about offsetting climate change effects. In addition, as you state that there are no increases in soil C, even the term C accrual does not fit well either. Thus, better use potential C accrual.

L325: Also here, be careful with the term C sequestration. Here, I suggest to use …seeking to increase C accrual (or C stocks)….

L327: How can the Tovetorp grassland drive the increase in aboveground plant biomass? Unclear and fuzzy. What is a grass rich plot? Unclear. How can you make a statement about effects of plant community composition when you never measured it? The fact that C in the 0-5 cm plot was higher in that site could also have an effect, as you basically want to state more Soil C = more biomass. This whole conclusion here is not convincing yet and needs to be revised and sharpened. What is it that you want the reader to take as a take home message from this chapter? I could not tell yet. The last sentence here could for example be a statement/conclusion in 1 sentence about the compost effect on soil C (stocks?) and plant growth based on what you said before in this chapter. This (as of now lacking) key message would also allow the reader to better follow then the drought effects chapter.

L333-336: This statement in these lines is correct. Now take this into account when discussing my comment above for L301-302.

L338: Does your weather data availability allow to also look at the distribution of rainfall along the seasons? As you mention it in L333-334. That would be helpful.

L333-348: This paragraph could move to materials and methods as the site description. Here, you do not discuss your drought treatment effect and thus this section does not really fit in here.

L347-348: This is purely hypothetical and you have no reference nor data on this. I suggest to add references with a statement about how much this could in similar situations affect the data you have. If I only read the text as is, I could think that the result of the experiment is pure coincidence and that we could learn nothing from this data (which is not true!). Thus, put it into context and add a number about how much e.g the drought effects could be weakened.

L349-351: How so? I cannot follow how plant community fits in here and how this is linked to your results, as you did not measure plant community structure

L351-353: Where are those results?

L362-372: And how is this linked to your study and results? Be precise, do not imply it, state it and name the link. Also, this whole paragraph could be shortened and condensed.

L373-379: How does this link to your study and why is it relevant? The second half from L379 on is relevant, this part could be cut.

L379-388: You mentioned already before, that your experimental drought may not be intense enough, and you focus again on microbial activity. This whole chapter reads not like you explaining what you found/measured/observed but rather like: We did not find anything and here are the "excuses". This chapter needs rephrasing. Focus less (but mention!) what may have gone wrong (e.g. drought intensity) and then talk about what you found and what your data allows for interpretation. In addition, C storage in soils is a process that takes longer time scales than the time interval you measured. E.g. if you change your agricultural management (i.e. introducing cover crops to arable land) the C stocks may increase (through increased biomass and thus C input). This increase is not measureable after 3 or 4 years and not with so few samples as you have. E.g. for soil C monitorings timesteps of 10 years and thousands of samples are needed to identify reliably if C stocks actually did increase. This is a longterm process and thus I am not surprised that you did not find many differences. Apart from adding C via manure, which of course immediately increases the C stocks.

L396: What do you mean "slightly"? Significantly? If not, then better state "tended to reduce"

L397: Figure 4 is not showing this. There you see the treatments excluded. In Figure 2 you see the treatments. There is no difference in R:S ratio. This needs to be corrected and changed.

L397-403: Here, we would need references, if any of this will remain after the reanalysis of the comment of line 397.

L406: vegetation C content was one of the goals? Then why was there no data on the C content of the plants? Cut this part or rephrase.

L 407-408 No it did not. The changes in roots are insignificant and there is not even a pattern, for shoots you are right.

L408-409: No, it did not. Fig 2 shows that shoot biomass in the compost treatment was different from all other treatments.

L410: Where do you see these changes in C allovation? Not in Figure 2.

L411: How do they improve our understanding? Tell us.

L412: How can your findings contribute to improve modelling? Unclear and not discussed in the discussion part at all. Thus, this cannot be concluded.

L414: Why do you leave out the part about the effect of precipitation which you mentioned in the discussion?

L415-416: Yes of course. But this has been known before and is nothing new found by your study. This sentence could have been stated like this even without your study and thus does show the value of your study.

Specific comments:

L23-24: add some sources e.g. 4permille initiative, EU green deal, Farm to fork. Anything to show this increased interest

L27: "Sometimes": This makes me wonder, what it is called other times. Either cut the sometimes or give 1 or 2 more other names

L33-36: This is basically, what C sequestration in soils means. I would move this up and use the term C sequestration in soils thereafter.

L 34-43: You are right with what you say and here we need some literature references to back the mentioned topics up.

L37: "directly increases the standing stock of SOC" instead of "standing" I suggest to use "local" or "SOC stock of the site"

L42: Wording. The term "Soil C sequestration" is currently under debate as it suggests soil carbon is sequestered when in fact atmospheric carbon is being sequestered in soils. Thus, I suggest to write "potential C sequestration in soils"

L43: ….contributions *to soil C stocks*.

L43-44: You could also mention that roots are 2/3 more recalcitrant to decomposition and thus of a different quality that above ground biomass and thus better suited when trying to sequester C in soil

L44-47: Please add a reference or two

L52: "whether through conventional or regenerative methods" I would cut this part. It does not add any information and if you mention it you should clarify what "regenerative" methods are and what not. To avoid getting side tracked, I suggest to cut this.

L52-54: Already mentioned e.g. in L25-26. Redundant. Rather make a bridge from the last paragraph over to amendments.

L63: see my specific comment on line 42

L62-68: but this is also true for cropland. Why only consider grassland here when you talked about all agricultural land before?

L70: here you go back to crop yields e.g. cropland. Looking at the comment above, you switch randomly between all agricultural land, then specifically crop or grassland and back to all agricultural land. I suggest to harmonize it and talk about all agricultural land as long as possible until you get really into the details of grasslands and the topic you want to focus on.

L80: Agreed. But why on grassland? Stress the lack of data there more.

L86: Their? What does this refer to? The yearly droughts or the yearly droughts and the compost application? Fuzzy, please specify

L87: soil organic C measured and soil C stocks. Please explain to the reader how SOC and C differ from one another and how these are linked. If I know little about soil C I would wonder how you measure SOC and then derive C stocks and not SOC stocks. Too fuzzy and needs to be cleared up to ensure that everyone understands what you did.

L90: Why did you hypothesize this? This needs to be better linked to the introduction text.

L99-102: Move to M&M

L108: wording…I suggest: Today, the land management consists of grazing and hay production.

L112: It would be great to know the soil type for the 4 sites, e.g. are we talking about Cambisol and a more exact texture would be great, if available.

L115: Mention the value so we can see the difference.

L157-159: Consider to split this sentence into two. I needed to read it 3 times to follow along.

L167: "compost or drought-no compost)" add here a "respectively" after between "compost" and ")".

L184: "the C isotopic ratio" better delta 13C ratio. Be consistent.

L185ff: What is this "model"?

L187: "Landscape variability" Do you mean the position in the slope? Please explain.

L198: I suggest "The drought treatment" to be 100% clear, that this is a treatment and not a "normal" drought. In case the reader skips right to this chapter.

L200: You mention spring and summer (=seasons) then you mention also growing season. How is this defined, what time is the growing season? Please add.

L205-209: It would be informative to see the standard deviation of these numbers as well.

L214: This sentence is already an interpretation which belongs to the discussion part. I suggest to rephrase e.g. In the compost treatment total soil C content and aboveground biomass was increased.

L218: Was N significantly increased or not? Please add a p value

L220: "the C:N ratio" add: significantly. Because N content increases as you stated in the sentence before, so the C:N ratio must be affected even if it is not significantly.

L222: I suggest to rephrase: ....did not correlate with any other variable. Because if you state compost has an effect on X and Y you already interpret, which belongs to the discussion part.

L223: Rephrase to avoid the aforementioned interpretation issue: "In the drought treatment aboveground biomass was decreased.... " Check throughout the results chapter, in case I missed a sentence. Also, was this reduction significant?

L225: reduced bulk density

L227: unclear, is this now for the compost x drought plots or all compost plots? And slightly higher means insignificantly? If so add a P<0.05 to be clear on this.

L238: as mentioned before, rephrase to avoid interpretation. In the drought treatment we observed an increase in root tissue density.....

L238-239: Too fuzzy, be more specific. This increase was in all drought treatments i.e. drought and drought x compost?

L244: Sometimes topsoil is 0-5cm, 0-15, 0-30 and here now 5-10cm. To be more coherent, I suggest to stick to the layers, and if the topsoil is meant, always consider the 0-30cm (or however you want to define it, traditionally it would be 0-30cm, some use 0-15, others 0-25). Please check and adjust in the whole manuscript.

L244: correlation in which direction? Positively? Negatively? Please add.

L246: correlation in which direction? Positively? Negatively? Please add.

L249: what is "constant"?

L250 "indicated" Either all in present tense or all in past tense. Avoid to switch, keep it consistent. Also what are "both groups"? For consistency stick with treatments)

L250-252: This is an interpretation and belongs to the discussion part.

L259-260: This, after "suggesting" is an interpretation and needs to move to the discussion.

L270-273: Changes in which direction? Increases, decreases? The curious reader wants to know this. You give this information from L274, so you can cut everything before, as it gives no information.

L294: add a reference for the respiration loss and put into context if this loss is what was expected or higher or lower than one would expect.

L295: recalcitrant type, what does this entail? Is there a clear definition or recalcitrant compared to what? Be more specific. It would be important to also mention that already lots of C is lost when producing the compost to ensure that the reader know this and does not think that compost is a solution to keep **all** C longer in the soil.

L295: effects on what? Be more specific

L298: this part of the sentence could be cut.

L299: cut the word conclusion.

L306: How does it stress this importance? Unclear, as the sentence before is unlcear.

L307-308: In line 292, you already confirmed your 1st hypothesis. Rephrase there.

L308: too fuzzy. Investment of what? Into biomass? Into C incorporation into different parts of the plant? Be more specific.

L307-312: This could be shortened (does not have to be). All of this is well known and thus does not need to be explained so long.

L312-313: What pool? Too fuzzy. The soil C pool and the vegetation C pool. In which direction was it shifted? Be more specific. Also, why not vegetation pool, if you can distinguish more exactly between below and above ground biomass? Thus, the more "general" part of the sentence could be cut.

L314: here you are in present tense. Above in past tense. Keep it consistent.

L316: did others find that as well or are you the first one? A reference would be good.

L326: such as? E.g. soil ad climate could be named.

L332: I read the exact same sentence in the chapter before. Rephrase to keep it interesting. Also here, add what you mean by "investment". What is invested?

L333-336: Rephrase, too complex of a sentence for easy text flow.

L349: Please be precise, what do you mean by "plant biomass"? below? Aboveground? Both together?

L390-393: can be cut. Not based on data from this study and could be move to the introduction. Here, the reader wants to see what your results could mean.

L399: better: "drought conditions"