

Comment on soil-2021-45

Anonymous Referee #2

Referee comment on "Biochar alters hydraulic conductivity and impacts nutrient leaching in two agricultural soils" by Danielle L. Gelardi et al., SOIL Discuss.,
<https://doi.org/10.5194/soil-2021-45-RC2>, 2021

Application of biochar to bind nutrients in soil and alter hydraulic properties of the soil is an important and relevant topic for large scale application of biochar in agricultural fields. The authors of this current paper have tried to add more insights into the existing literature in this context. Overall, after a first glance through, the reader can follow the main message of the paper. However, I have a few main points of concern regarding the manuscript:

- The title of the paper states "inhibits nutrient leaching" – the data for nitrate does not necessarily show this.
- There lacks a sense of novelty in the experimental approach of the manuscript. Experimental details are missing especially for the column studies.
- A more mechanistic insight would have been interesting. Key factors which would have been critical for achieving this and making a more impactful statement are (i) measurement of point of zero charge (for supporting any statements using electrostatic repulsion or attraction) (ii) measurements of anions and cations released during column nutrient leaching tests (iii) use of non-reactive tracers such as "deuterated water" could have been an interesting approach to understand movement of water through columns, etc.
- The term "physical and chemical interactions/affinity" is used very lightly and often in the manuscript without providing concrete proof for these interactions.
- An in-depth literature study in the discussion would have provided readers with more confidence in the conclusions that the authors wished to make.
- The entire sense of "timing of release of nitrate" and its importance needs to have been brought to light. Is it sufficient for nitrate to be captured physically for a short duration and then released?
- The entire discussion in Section 4.3 is underwhelming.

Abstract and Introduction

Line 47-48 – this is not always true. There are some biochars which have a PZC of 7.5 or higher and then they might be positively charged.

Line 85 – Suggestion is to introduce what is saturated hydraulic conductivity out here itself.

Line 91 – how is the biochar “physically altering the soil to influence K_{sat}?”

Materials and methods

Line 105 – From which four commercial companies?

Line 107 – What is the inoculated microbial formula?

Line 137 – Do not see the need to specify ongoing field trials if there is no connection with the current paper.

Line 156 – It makes more sense to present electrolyte concentrations on a mM or M basis, to normalize it. Why is this test done with NaCl and the column tests with CaCl₂?

Line 165 – Which are the “multiple equations”?

Line 175 – How were the columns packed? Was the biochar homogeneously mixed with the soils? How was existence of preferential flow ruled out? Any tracer? What was the flow rate and the pore volume? Experimental details for reproducibility is missing in general.

Lines 175-184 – Why was k_{sat} measured for 2 soils, whereas sorption for only 1?

Results

Line 196 – increased pyrolysis temperature usually increases carbonization.

Line 268 – what do you mean by “main effect”? p values correspondence not clear.

Figure 4- It is very hard to discern the data and the decrease in leaching of NO₃ from the control to HSL+SW500. Please consider to reduce the y axis from 100 mg/L to something smaller (4(a)) to make the graph better accessible (in regards to the data in the text) for the readers.

Discussion : In general, the discussion is not sufficient, and needs better structuring, with more references.

Line 324-329 –This explanation is a bit underwhelming. A more mechanistic approach to this would have been to also measure cations and anions in solution – if nitrate is bound to positively charged components in the ash, one should see some anions being released. PZC measurements would have been crucial in the experimental design, since a lot of the reasoning is based on “electrostatic repulsion”.

Line 340-342 – A tracer study using “deuterated water” or something similar would have been a more mechanistic way to explain the movement of water through biochar packed columns.