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Interactive comment on "Investigating the impacts of biochar on water fluxes in tropical agriculture using stable isotopes" *by* Benjamin M. C. Fischer et al.

Anonymous Referee #2

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The authors examined the water sources of rice crop plants in soils amended with two different biochar types in comparison to non-amended soils (control treatment) in a seasonally dry tropical region in Costa Rica. For this, they used stable isotope signatures of precipitation, irrigated water, soil-lysimeter water, ground water and plant stem in combination with soil moisture and matric potential and climate data. Overall, their findings showed increases of plant available water in amended soils and, across treatment plots, the stable water isotope composition of plant water showed that the rice plants preferentially used water from the first 20 cm of soil.

The main objective of this study was to investigate plant water sources. As background

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information provided (L113-115), the study of Shen et. (2015) showed that flooded rice consumed soil water from 0-15 cm deep, while the study of Mahindawansha et al. (2018) found that upland rice in dry conditions mostly consumed soil water from the first 50 cm of depth. Based on these findings, the authors hypothesized that amending biochar into the top 10-30 cm of the soil, could increase soil water storage and rice plants be able to use water from different soil water pools in comparison to plants grown in non-amended soils (L113-125) across the different time periods studied.

First, I should say that after the work of Brooks et al. (2020), countless studies across regions (including tropical wet environments; see Goldsmith et al. 2012; Muñoz-Villers et al. 2018) and revisions have showed that plants use evaporatively fractionated soil water (Sprenger et al., 2016; Sprenger and Allen 2020). The general finding is that plant water is isotopically similar to bulk soil water but not to low suctionâĂŘlysimeter water, implying that roots are generally located in less conductive (mobile) pores where water tends to travel more slowly and can reside for longer times.

In the present study, soil water samples representing the soil water pool for plants, were only collected using low suction (80 kPa) lysimeters. Bulk soil samples were a key part of the experiment but they are missing here. This methodological issue, is perhaps the largest flaws of the research and I do not see a way to get out of it, based on all the evidence published over the last decade.

In addition, your soils are dominated by clay content (Table A1) which is very well known for its very fine particle structure making very difficult to empty the water from such smaller pores using low soil tension lysimeters. This is other reason why the authors should have collected and used bulk soil water isotope ratios (from cryogenic vacuum distillation) as the representative soil water source for plants. I also observed that your samplings 9,10 and 11 corresponding to Period III (Figure 4), were characterized by low soil water contents held at very high tensions (close to PWP conditions). Hence, the soil water collected with soil lysimeters was not “seeing” the water that plants were extracted during this dry period. This situation is particularly observed for the biochar

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amended treatments. Therefore, the research question 2 cannot be answered.

I have made some other important comments that the authors can also consider when preparing other articles around these topics:

1) The use of mixing models to quantify the relative contributions of the different plant water sources, instead of reporting the results in a visual graphical and/or descriptive way only.

2) The construction of dual isotope space figures in which the plant and the different water sources are plotted together. In this way, it is easier the assess the isotope information per sampling period and seasons (Figure 7 and 8).

3) Both water isotopes (δ2H and δ18O) were determined for the plant and potential water sources, however, the results were only elaborated around 18O. I would suggest you to describe both isotope ratios.

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