Hydrology and Earth System Sciences Discussions

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Reply on RC1

Shaofei Wang et al.

Author comment on "The natural abundance of stable water isotopes method may overestimate deep-layer soil water use by trees" by Shaofei Wang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-142-AC1, 2022

Anonymous Referee #1

With great pleasure I read your manuscript, where you investigate the water use strategy of apple trees by different ages. You injected labeled water (D_2O) and studied at which depth the trees withdraw their waters. This analysis was carried out for three different growing stages. The paper is very well structured, easy to read, informative figures and in good English language. The applied method is correct and I have no comments about the conclusion. Hence my comments limit mostly to technical issues, except from the following two comments:

Response: Thank you very much for the constructive and encouraging comments and giving us an opportunity to revise this paper. Corrections have been made based on the recommendations, and the detailed response to each comment is presented as follow.

Comment 1

From a scientific point of view your work is really interesting, but the question remains what we can do with this information (social relevance). Furthermore, the study only looks at one growing cycle and ignores that water use strategies change depending on water availability (or climate). In case plants experience dry spells, their roots develop differently in comparison to plant that do not experience dry spells. So there is also a long-term strategy, where plants (sometimes) can adapt to climate change. Could you discuss on this topic?

Response: Thanks for your comments. Here are our responses.

(1) The Loess Plateau is the largest apple tree cultivation zone globally and apple yield accounts for 27% of global production, involving more than 10 million farmers (Gao et al., 2021). However, drought and water shortage in this region are serious and most orchards have no irrigation water source, causing apple trees to heavily rely on deep-layer soil water (DLSW). Therefore, it is of great significance to determine the utilization time of DLSW for orchard water management and apple yield improvement. We will add the social relevance of the findings in the Discussion section (L 320-324).

References

Gao, X., Zhao, X., Wu, P., Yang, M., Ye, M., Tian, L., Zou, Y., Wu, Y., Zhang, F., and Siddique, K. H. M.: The economic–environmental trade-off of growing apple trees in the drylands of China: A conceptual framework for sustainable intensification, J. Clean Prod., 296, 126497, https://doi.org/10.1016/j.jclepro.2021.126497, 2021.

(2) We agree that water use strategy can be changed by climate. The apple trees are expected to use more soil water in deeper soils in dry spells. We will add more details in the Discussion section to explain this point (L 329-344).

"Our results show that apple trees switch their water sources between different soil layers to adapt to the changing water environments on the Loess Plateau, which is particularly important in the context of future climate change. Special attention should be directed to water consumption in deep soils—we found that apple trees absorbed the most water from deep soils during the BYF stage, with 17-year-old apple trees consuming more water in these layers than 11-year-old trees throughout the growing season. This result is in accordance with previous observation in this region that soil water availability gradually decreased with increasing stand age, and then apple trees absorbed more water from deeper soil layers (Li et al., 2019). Similarly, Barbeta et al. (2015) found that trees increased their use proportion of deep soil water and groundwater following a long-term (12 years) experimental drought. However, this may not be sustainable, especially in deep vadose zone (DVZ) regions. The result of the tritium peak method suggested that it took more than 50 years for soil water migration to 6 m depth in apple orchards in DVZ regions (Li et al., 2018). Thus, once deep-layer soil water is depleted, it cannot be replenished within a short timeframe, reducing the tree's ability to resist water stress. Also, Wu et al. (2021) observed that soil water generated by precipitation was the primary water source for apple trees when deep soil water was depleted, dominating their transpiration. In this case, trees were likely to encounter irreversible embolism, increasing the risk of drought-induced mortality, threatening the sustainability development of vegetation and changing regional hydrological cycle (Brodribb et al., 2020; Zhang et al., 2020). Therefore, we suggest that long-term and high-frequency monitoring of isotopes in soil and xylem water is necessary, especially at large geographical scale, to further understand the long-term changes of plant water use strategy and evaluate their adaptability under climate change."

References

Barbeta, A., Mejia-Chang, M., Ogaya, R., Voltas, J., Dawson, T. E., and Penuelas, J.: The combined effects of a long-term experimental drought and an extreme drought on the use of plant-water sources in a Mediterranean forest, Global Change Biol., 21, 1213-1225, 10.1111/gcb.12785, 2015.

Brodribb, T.J., Powers, J., Cochard, H., and Choat, B.: Hanging by a thread? Forests and drought, Science, 368(6488), 261-266, DOI:10.1126/science.aat7631, 2020.

Li, H., Si, B., and Li, M.: Rooting depth controls potential groundwater recharge on hillslopes, J. Hydrol., 564, 164-174, 10.1016/j.jhydrol.2018.07.002, 2018.

Li, H., Si, B., Wu, P., and McDonnell, J. J.: Water mining from the deep critical zone by apple trees growing on loess, Hydrol. Process., 33, 320-327, 10.1002/hyp.13346, 2019.

Wu, W., Li, H., Feng, H., Si, B., Chen, G., Meng, T., Li, Y., and Siddique, K. H. M.: Precipitation dominates the transpiration of both the economic forest (*Malus pumila*) and ecological forest (*Robinia pseudoacacia*) on the Loess Plateau after about 15 years of water depletion in deep soil, Agr. Forest Meteorol., 297, 108244, https://doi.org/10.1016/j.agrformet.2020.108244, 2021.

Zhang, Z., Huang, M., Yang, Y., and Zhao, X.: Evaluating drought-induced mortality risk for Robinia pseudoacacia plantations along the precipitation gradient on the Chinese Loess Plateau, Agr. Forest Meteorol., 284, 107897, https://doi.org/10.1016/j.agrformet.2019.107897, 2020.

Comment 2

Data availability: I don't think the current data-statement is sufficient. Data that is used in publications should preferable be available online and not "upon request". The latter is only possible in exceptional cases. If this is the case, this should be justified.

Response: We agree. We will make changes in the revised manuscript (L 361).

"The data that support the findings of this study are provided in Supplement."

Technical issues:

L60: BYF is note explained in the main text (only in the abstract). I think it's good practice to define abbreviations the first time you mention them in the main text.

Response: We agree. We will make changes in the revised manuscript (L 60).

"Wang et al. (2020b) stated that the heavy absorption of deep soil water only occurred during the blossom and young fruit (BYF) stage in apple orchards".

L88: unit of annual rainfall in mm/y.

Response: We agree. We will make changes in the revised manuscript (L 88).

"Mean annual precipitation in the study region is 507.9 mm/y".

Table1: I would recommend to change the way the units are provided. I would skip the '/' and use brackets.

Response: We agree. We will make changes in the revised manuscript (L 96).

The Table 1 is given in the supplemental document attached.

L155-and further: all variables/parameters should be in italic.

Response: We agree. We will make changes in the revised manuscript (L 155-156).

"Figure 2 shows the total precipitation (P_t) and growing season (April to September) precipitation (P_g). P_t and P_g in 2019 were 522.1 mm and 442.3 mm, respectively, similar to the multiyear (1999–2018) mean (507.9 mm/y for P_t and 407.5 mm/y for P_g)."

L156: "mean annual P_t": this is long-term P_t? If so, provide period. Furthermore unit should be mm/y.

Response: Yes, "mean annual P_t" is long-term P_t. The period will be added in the revised manuscript (L 155-157).

"P_t and P_g in 2019 were 522.1 mm and 442.3 mm, respectively, similar to the multiyear (1999–2018) mean (507.9 mm/y for P_t and 407.5 mm/y for P_g)."

L156-157: but the monthly rainfall can differ a lot (see figure2b). So is 2019 a normal year?

Response: The study area is located in China's Loess Plateau, its most significant climatological characteristics are distinctly seasonal precipitation, approximately 55-78% of which falls in June through September (Fu et al., 2017; Jia et al., 2017). In 2019, 74.9% of the precipitation in study area fell in June through September, according with the seasonal distribution characteristics of precipitation in the Plateau. In addition, the total precipitation (P_t) and growing season (April to September) precipitation (P_g) in 2019 were 522.1 mm and 442.3 mm, respectively, similar to the multiyear (1999–2018) mean (507.9 mm/y for P_t and 407.5 mm/y for P_g). Thus, 2019 was considered a normal precipitation year. We will make changes in the revised manuscript (L 157-159).

References

Fu, B., Wang, S., Liu, Y., Liu, J., Liang, W., and Miao, C.: Hydrogeomorphic Ecosystem Responses to Natural and Anthropogenic Changes in the Loess Plateau of China, Annu. Rev. Earth Pl. Sc., 45(1), 223-243, DOI:10.1146/annurev-earth-063016-020552, 2017.

Jia, X., Shao, M., Zhu, Y., and Luo, Y.: Soil moisture decline due to afforestation across the Loess Plateau, China, J. Hydro., 546, 113-122, DOI:10.1016/j.jhydrol.2017.01.011, 2017.

Fig 2: unit of precipitation is mm/day (LEFT) and mm/month (RIGHT).

Response: We agree. The Figure 2 will be revised in the revised manuscript (L 163).

The Figure 2 is given in the supplemental document attached.

Fig 5: I would rotate this figure 90 degrees, so you can more easily compare the figures with fig 3, 4, and 6.

Response: We agree. The Figure 5 will be revised in the revised manuscript (L 191).

The Figure 5 is given in the supplemental document attached.

L212: "with relative higher reliance": I am not fully understand this sentence. Could you explain?

Response: It means that the contribution proportion of water from 140–320 cm soil layer both exceeded 48% in BYF stage for 11- and 17-year-old apple trees, which was higher than other stages. To clarify it, we will reorganize the sentence (L 216).

"The BYF stage produced more negative isotopic values in xylem water for 11- and 17-year-old apple trees (Fig. 7), which mainly utilized water from 140–320 cm soil layer (more than 48%)".

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2022-142/hess-2022-142-AC1-supplement.pdf