Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-266-AC4, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Preferential water flow through decayed root channels enhances soil water infiltration: Evaluation in distinct vegetation types under semi-arid conditions" *by* Gao-Lin Wu et al.

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Received and published: 11 December 2020

Response to Reviewer #1:

We thank the reviewers for arranging time to read and review our paper and providing suggestions and comments, which will help us improve the manuscript. We will try our best to modify and improve the manuscript following the reviewer's suggestions/comment.

Comment #1: This manuscript (MS) looks into the effect of live and decaying plant

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roots on soil-water infiltration using a double-ring infiltrometer and dye solutions. Alas, this study is of uncertain quality and, in my opinion, needs substantial work before it can be considered further for publication in HESS and elsewhere. The study is not placed into context, as the wider body of related studies are not adequately mentioned or discussed, the existing knowledge gaps related to the study topic are not indicated nor addressed, the aim and objectives are not mentioned, and there is a severe lack of detail and justification throughout the MS, particularly in the methodology and results Sections. The latter issue has a knock down effect, making it unclear to the reader what the authors actually did, and why, how the results were collected, and more importantly, which results were actually retrieved to merit being published. As it stands, it seems like just a series of infiltration tests were undertaken with a clear, yet unexplained, deviation from standard, which derived into a series of results that in spite of being good and sensible, they are rather trivial and expected. A way forward for the authors would be: (i) to providing more detail, (ii) to place the study in context (i.e. knowledge gaps), (iii) to demonstrate how the study addresses some of the knowledge gaps with supporting information from the results, and (iv) stress the impact and application of the study. Please, see below some specific comments.

Response: Thank you for your suggestion. Your suggestions were very helpful in making a better manuscript. We will try our best to modify and improve the manuscript following the reviewer's suggestions/comment.

L.29 the scope/background of the study is not clear from the two first sentences - 'phenomenon of dried soil layer' is unclear and misleading.

Response: Thank you for your suggestion. I am sorry for my unclear description. Large-scale vegetation construction could aggravate soil water consumption and gradually lead to soil desiccation in arid and semi-arid regions. Dried soil layers are usually caused by excessive consumption of deep soil water by vegetation when there is not enough precipitation (Huang et al., 2018). Dried soil layers generally occur below the depth of soil affected by rainfall infiltration, it greatly affects the growth of plants (Li,

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2001; Jia et al., 2015). Macropores formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, the preferential flow formed by decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers. And, we will add the required in formation in the revised version of the manuscript. (Additional reference) Huang, Z., Liu, Y., Cui, Z., Fang, Y., He, H. H., Liu, B. R., Wu, G. L.: Soil water storage deficit of alfalfa (Medicago sativa) grasslands along ages in arid area (China). Field Crops Res., 221, 1–6, 2018. Li, Y. S.: Effects of forest on water circle on the Loess Plateau. J. Nat. Resour., 6, 427–432, 2001. Jia, X. X., Shao, M. A., Zhang, C. C., Zhao, C. L.: Regional temporal persistence of dried soil layer along south–north transect of the Loess Plateau, China. J. Hydrol., 528, 152–160, 2015.

L.33 the Latin/scientific names of the plant species do not match the common names.

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

L.34 bare land -> fallow conditions

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

L.34 this is not introduced -i.e. the methodology must be summarised more clearly in the abstract, for which the authors could be more generic - e.g. infiltration tests using a dye under living and decaying vegetation...

Response: Thank you for your suggestion. We fully agree with this comment and we will modify the text following the reviewer's suggestion.

L.39 not clear here how/whether/why the root systems were described.

Response: Thank you for your suggestion. I am sorry for my carelessness. Our intention was that under the condition of the same root diameter, the decayed root plots could significantly improve the infiltration capacity of soil water than the alive root plots.

The manuscript will be carefully revised to convey clear meaning.

L.43 do you mean arid or water-limited ecosystems? Professional proof reading is needed!

Response: Thank you for your suggestion. Your comment is correct. We will use "water-limited ecosystems" instead of "water-scarce regions".

Also, there is a bigger picture here than the one proposed by the authors.ÂăThis is related to the effect of land use change - e.g. woodland removal/clear cutting.

Response: Thank you for your suggestion. Although we fully agree with this comment/suggestion, our aim was to focus on the impact of preferential flow formed by dead roots on soil moisture. Large-scale vegetation construction could aggravate soil water consumption and gradually lead to soil desiccation in arid and semi-arid regions. However, water scarcity is the key limiting factor for the growth of vegetation in semi-arid regions.ÂăPrevious studies have addressed the effects of root systems on soil water infiltration, but the effects of root channel formed by decayed roots after vegetation die off on soil water infiltration and soil water storage are still not clear. Meanwhile, most studies have concentrated the research on one plant type or species (Wu et al., 2016; Jiang et al., 2018; Guo et al., 2019), neglecting the comparison between different plant types. Therefore, this study explores the effects of decayed and alive roots on soil infiltrability in three common vegetation types (shrubs, fruit trees, and herbs) in semi-arid regions, and determines the contribution of the preferential flow to soil water. The results of this study indicate that macropores formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, the preferential flow formed by decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers.

L.45 surely the authors can choose better key words

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

L.51 'the' soil-plant-atm continuum

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

L.55 this sentence is not clear, also it is not clear how DSL is related to plant cover establishment, soil degradation, etc. a connection has to be made.ÂăIt is hard to understand what the authors mean by recharge of soil water in relation to the previous sentence, were the authors are referring to groundwater flow...

Response: Thank you for your suggestion. Dried soil layers (DSL) are usually caused by excessive consumption of deep soil water by vegetation when there is not enough precipitation (Huang et al., 2018). DSL generally occurs below the depth of soil affected by rainfall infiltration, it greatly affects the growth of plants (Li, 2001; Jia et al., 2015). Macropores formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, the preferential flow formed by decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers. And, we will add the required in formation in the revised version of the manuscript. (Additional reference) Huang, Z., Liu, Y., Cui, Z., Fang, Y., He, H. H., Liu, B. R., Wu, G. L.: Soil water storage deficit of alfalfa (Medicago sativa) grasslands along ages in arid area (China). Field Crops Res., 221, 1–6, 2018. Li, Y. S.: Effects of forest on water circle on the Loess Plateau. J. Nat. Resour., 6, 427–432, 2001. Jia, X. X., Shao, M. A., Zhang, C. C., Zhao, C. L.: Regional temporal persistence of dried soil layer along south–north transect of the Loess Plateau, China. J. Hydrol., 528, 152–160, 2015.

L.56 water infiltration is a hydrological process but groundwater isn't (it is a noun, not a process) - please clarify how groundwater may affect soil moisture.

Response: Thank you for your suggestion. When the groundwater level is high, the soil moisture will be replenished by groundwater. We will revise this sentence to convey clear meaning following the reviewer's suggestion.

L.57 macropores not defined

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

Preferential flow not defined

Response: Thank you for your suggestion. Preferential flow means that soil receives replenishment on the entire inflow boundary, but moisture and solute bypass the soil matrix and move quickly through a small part of the soil. We will add relevant information about preferential flow in the revised version of the manuscript.

How plant roots may regulate preferential flow below ground is not explained or introduced.

Response: Root system characteristics (such as root diameter, root density, etc.) determine the decay and decomposition rate of the root system. The macropore flow formed by the root channels is considered to be the main effect factor on preferential flow (Weiler and Naef, 2003). Preferential flow formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, the decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers. Âă

L.59 this sentence is not connected to the previous one - and it seems out of scope - i thought you were talking about plant roots and pref flow. . .

Response: Thank you for your suggestion. Your comment is correct. We will modify the text following the reviewer's suggestion.

L.63 all these sentences seem redundant - i.e. no new or clarifying information is

provided, it seems like the authors are talking in circles - please, establish a logic structure in which concepts/ideas are introduced adequately to then elaborate further in the light of the scope of your study.

Response: Thank you for your suggestion. We fully agree with this comment and we will add the required information and be rewritten following the reviewer's suggestion.

L.64 not clear what is the role of plant decay here or how it is species-specific

Response: Thank you for your suggestion. Root system characteristics (such as root diameter, root density, etc.) determine the decay and decomposition rate of the root system. Macropores formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, the decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers.

L.65 root density is not defined and the sentence after the comma does not clarify the previous one.

Response: Thank you for your suggestion. We fully agree with this comment and we will add the required information and be rewritten following the reviewer's suggestion.

L.66 studied alfalfa fields, with what aim

Response: Thank you for your suggestion. Previous studies have addressed the effects of root systems on soil water infiltration, but the effects of root channel formed by decayed roots after vegetation die off on soil water infiltration and soil water storage are still not clear. Meanwhile, most studies have concentrated the research on one plant type or species (Wu et al., 2016; Jiang et al., 2018; Guo et al., 2019), neglecting the comparison between different plant types. Therefore, this study explores the effects of decayed and alive roots on soil infiltrability in three common vegetation (Caragana korshinskii, Armeniaca vulgaris, and Alfalfa) in semi-arid regions, and determines the contribution of the preferential flow to soil water. This study can provide a theoretical

basis for the restoration of soil moisture in arid and semi-arid region.

L.67 restoring water conditions to respect what previous state?

Response: Thank you for your suggestion. I am sorry for my carelessness. The meaning of this sentence is that roots decay is conducive to the restoration of soil moisture, especially the replenishment of deep soil moisture. The sentence will be rewritten to convey clear meaning.

L.68 why is this important?

Response: Thank you for your suggestion. Large-scale vegetation construction could aggravate soil water consumption and gradually lead to soil desiccation in arid and semi-arid regions. Desiccation are usually caused by excessive consumption of deep soil water by vegetation when there is not enough precipitation (Huang et al., 2018). However, water scarcity is the key limiting factor for the growth of vegetation in semi-arid regions. Macropores formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Therefore, the replenishment of deep soil moisture by the decayed root system is beneficial to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of soil desiccation. (Additional reference) Huang, Z., Liu, Y., Cui, Z., Fang, Y., He, H. H., Liu, B. R., Wu, G. L.: Soil water storage deficit of alfalfa (Medicago sativa) grasslands along ages in arid area (China). Field Crops Res., 221, 1–6, 2018.

L.69 how this connects to land management? it is hard to understand how land managers can make use of soils with decaying roots, please elaborate.

Response: Thank you for your suggestion. I am sorry for my unclear description. We will revise and rewrite this sentence to convey clear meaning following the reviewer's suggestion.

L.71 do you mean vegetation type?

Response: Thank you for your suggestion. Your comment is correct. We will use

"vegetation type" instead of "plant".

L.75 how tree plantations can be a phenomenon?

Response: Thank you for your suggestion. Red plum apricot not only can easily survive in arid and semi-arid environments, but also have great economic value. Therefore, red plum apricot was planted in large areas in this region. The sentence will be rewritten to convey clear meaning.

L.78 which plants?

Response: Thank you for your suggestion. These plants refer to various types of vegetation, such as trees, shrubs and herbs. And, we will modify the text following the reviewer's suggestion.

L.79 it is not clear how the channels may favour infiltration - preferential infiltration not defined yet

Response: Thank you for your suggestion. Preferential flow means that soil receives replenishment on the entire inflow boundary, but moisture and solute bypass the soil matrix and move quickly through a small part of the soil. Preferential flow formed by large channels can increase the infiltration rate of soil moisture. And, we will modify the text following the reviewer's suggestion.

L.84 citation missing

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

L.86 what is soil water reservoir? did you mean soil water retention capacity? please, use words/concepts that are widely used/understood by the international scientific community.

Response: Thank you for your suggestion. I am sorry for my unclear description. Soil water reservoir in the manuscript means soil water storage. And, we will modify the

text following the reviewer's suggestion.

Also, citation needed L.87 methods of study not outlined.

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

importance/impact of the study not outlined. knowledge gaps not outlined – the authors are not outlining the wider context in which this study rests.

Response: Thank you for your suggestion. Large-scale vegetation construction could aggravate soil water consumption and gradually lead to soil desiccation in arid and semi-arid regions. In addition to woodland, some shrubs and artificial grasslands resulted in soil desiccation. However, water scarcity is the key limiting factor for the growth of vegetation in semi-arid regions. Soil water content is highly dependent on water infiltration. Previous studies have addressed the effects of root systems on soil water infiltration, but the effects of root channel formed by decayed roots after vegetation die off on soil water infiltration and soil water storage are still not clear. Meanwhile, most studies have concentrated the research on one plant type or species (Wu et al., 2016; Jiang et al., 2018; Guo et al., 2019), neglecting the comparison between different plant types. Therefore, this study explores the effects of decayed and alive roots on soil infiltrability in three common vegetation types (shrubs, fruit trees, and herbs) in semi-arid regions, and determines the contribution of the preferential flow to soil water. The results of this study indicate that macropores formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, the preferential flow formed by decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers.

L.90 with what aim?

Response: Thank you for your suggestion. The aim was to focus on the effects of pref-

erential flow formed by dead roots of different.ÂăThis study can provide a theoretical basis for the restoration of soil moisture in arid and semi-arid region.

L.95 not clear connection with this SDG - and i am sure the authors can also find other related subjects linked to their study?

Response: Thank you for your suggestion. I am sorry for my unclear description. We will revise and rewrite this sentence to convey clear meaning following the reviewer's suggestion.

As the main knowledge gaps are not outlined and as the authors are not pointing to the reader which is the relevance of the study, it is hard to understand what is the relevance of this study. Having read the methodology, this study does not seem to be cutting edge or addressing a major knowledge gap in the field of study.

Response: Thank you for your suggestion. Although previous studies have addressed the effects of root systems on soil water infiltration, the effects of root channel formed by decayed roots after vegetation die off on soil water infiltration and soil water storage are still not clear. Meanwhile, most studies have concentrated the research on one plant type or species (Wu et al., 2016; Jiang et al., 2018; Guo et al., 2019), neglecting the comparison between different plant types. Therefore, this study explores the effects of decayed and alive roots on soil infiltrability in three common vegetation types (shrubs, fruit trees, and herbs) in semi-arid regions, and determines the contribution of the preferential flow to soil water. We will add the required in formation in the revised version of the manuscript.

A review on woks focusing on preferential flow carried out in Europe and USA is not provided at all...while i am aware there is a relative big number of existing studies.

Response: Thank you for your suggestion. Your suggestions were very helpful in making a better manuscript. And, we will add the required in formation in the revised version of the manuscript.

L.98 is there more than one study site?

Response: Thank you for your suggestion. I'm sorry that this research only selected one study site.

L.100 Coordinate Reference System?

Response: Thank you for your suggestion. The coordinate Reference System is WGS-84. We will add the required in formation in the revised version of the manuscript.

L.101what is the precise elevation of the study site?

Response: Thank you for your suggestion. The precise elevation of the study site is approximately 1750 m.

L.101 what kind of restoration was this?

Response: Thank you for your suggestion. The restoration measures of soil erosion in the study area mainly focus on vegetation restoration.

L.102 could you provide the time period used to obtain the mean climatic attributes? if someone reads this work in the future, this will help to understand how the climate has changed over time.

Response: Thank you for your suggestion. Sorry, I cannot provide the time period used to obtain the mean climatic attributes. Because the climatic data of the study area refers to Chai et al. (2019). This climate data is the average value of previous decades, but I am not sure of the specific time period.

L.104 did the soil had any gravel or coarser materials at all? could you also provide soil classification according to textural class? which were the hydrological features of the soil - e.g. saturated hydraulic conductivity, soil moisture at field capacity and at wilting point, porosity, bulk density....without more information for the soil under study, the results will be very hard to interpret or reproduce.

Response: Thank you for your suggestion. The soil of the experimental site has not been analyzed for soil texture, so we could not provide soil classification according to textural class. There is no gravel or coarser materials in the soil. Because the distance between all the experimental sites is very close, the background values of the soil properties of these experimental sites are almost the same before planting vegetation. The long-term growth of vegetation significantly affects soil properties. And, the difference in soil properties of the experimental site is mainly caused by the difference in vegetation root system. We only measured the soil water content, soil bulk density and soil porosity which are closely related to the soil water infiltration rate. However, we did not measure other soil properties (such as saturated hydraulic conductivity, field moisture capacity, etc.).

L.105 could you provide the Koppen classification code for this cliamte?

Response: Thank you for your suggestion. The Koppen classification code for this cliamte is Dwa according to Koppen Climate Classification System.

Why the 'sloping lands' were degraded? please replace 'sloping lands' with a more appropriate word

Response: Thank you for your suggestion. The soil degradation of slope land in this area is mainly due to the combined effects of long-term water erosion and wind erosion. And, we will modify the text following the reviewer's suggestion.

L.110 please, provide a jsutification for selecting these plant species. Also, Medicago sativa is not a grass - it is a herb

Response: Thank you for your suggestion. I am sorry for my carelessness. We will use "herb" instead of "grassland". Medicago sativa is one of the most important forage crops in the world because of its high nutritive value, drought-resistance and good adaptability to rigorous climate and poor soil conditions. Therefore, it is now the most widely promoted species for artificial grasslands, especially in arid and semi-arid re-

gions (Li et al., 2007). Caragana korshinskii is also the dominant species in this area because it can easily survive in arid and semi-arid environments. In addition, red plum apricot (Armeniaca vulgaris) not only can easily survive in arid and semi-arid environments, but also have great economic value. Hence, red plum apricot was planted in large areas in this region. Therefore, these three types of vegetation belong to species with larger planting areas in this area. (Additional reference) Li, X. L., Su, D. R., Yuan, Q. H.: Ridge-furrow planting of alfalfa (Medicago sativa L.) for improved rainwater harvest in rainfed semiarid areas in Northwest China. Soil Till. Res., 93, 117–125, 2007.

L.113 which old and which new data? this is very confusing - also it is not clear which data/which variables/why these variables, etc.

Response: Thank you for your suggestion. In order to have comparable values between the new (the experimental data of scrubland and fruit tree plantation) and old (the experimental data of grassland) data, we replicated the treatment conditions of the previous study that are the following: Bare land as control area, and alive and decayed specimens of C. korshinskii and A. vulgaris. We will add the required in formation in the revised version of the manuscript.

if you did not collect the info for Alfalfa, but you are reproducing the same conditions here than in a previous experiment for comparison purposes, you still need to give detail about the experiment -i.e. you cannot expect the reader to read two papers to understand one study...

Response: Thank you for your suggestion. A more detailed description has been added to the revised manuscript as below: Six experimental plots were randomly selected from the experimental site:Âăalfalfa (6 replicates) and bare soil (6 replicates). The double-ring infiltrometer was used to measure water infiltration. After selecting a level site, the litter layer was carefully removed so that the soil surface was exposed. Then, the rings (30-cm diameter inner ring, 60-cm diameter outer ring, both 20-cm in height) were placed concentrically on the soil surface and were gently inserted 10 cm

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vertically into the soil, in order to reduce crack formation. Some soil was then placed outside of the inner and outer rings to avoid water outflow. The inner and outer rings were filled with water, with and without methylene blue, respectively, until the water depth reached 5 cm at the same time in both rings. The falling head method was used to measure water infiltration. The time required to infiltrate water, up to the water level dropped 1 cm in the inner ring, was recorded with a stopwatch until the infiltration time did not change for three consecutive measurements.

L.113 Do you mean fallow?

Response: Thank you for your suggestion. Your comment is correct. We will modify the text following the reviewer's suggestion.

L.114 how many? how old? How did you select them?

Response: Thank you for your suggestion. The planting time and death time of the two types of vegetation (C. korshinskii and A. vulgaris) are determined by consulting data and consulting local residents. We will add the required in formation in the revised version of the manuscript.

L.116 what do you mean by artificial?

Response: Thank you for your suggestion. The artificial C. korshinskii in the manuscript means artificially planted C. korshinskii, not naturally grown C. korshinskii.

L.119 repeats L.119 were all individuals close to each other?

Response: Thank you for your suggestion. The plant individuals used in the infiltration experiment are all randomly selected, so there are differences among the individuals.

How the soil properties were characterised is not clear?

Response: Thank you for your suggestion. The soil in the study area is loessial soil with 26.6% clay, 62.0% silt and 11.4% sand (Chai et al., 2019). Because the distance between all the experimental sites is very close, the background values of the soil prop-

erties of these experimental sites are almost the same before planting vegetation. The long-term growth of vegetation significantly affects soil properties. And, the difference in soil properties of the experimental site is mainly caused by the difference in vegetation root system. We only measured the soil water content, soil bulk density and soil porosity which are closely related to the soil water infiltration rate.

L.120 why there is an uneven number of repeats?

Response: All treatments are 4 repetitions at the beginning. The infiltration data is checked after infiltration experiments. If there is too much difference in the infiltration data within the same treatment, we will make a supplementary test for the treatment. Hence, there is an uneven number of repetitions of different treatments in this study.

L.123 did the authors undertake the experiment according to standard? if so, which protocol did they follow?

Response: Thank you for your suggestion. The operation steps of the entire infiltration process of the study are based on Zhang et al. (2017). We will add relevant information about the infiltration process in the revised version of the manuscript.

L.124 could the authors provide a picture of the infiltrometer ring as suppl material? 1 cm wall thickness is quite thick. Was the ring inserted in the ground? if so, to which depth? The dimensions of the infiltrometer are not standard - could the authors justify this? deviations from standard should always be noted in the text.

Response: Thank you for your suggestion. For reducing the influence of artificial disturbance on soil structure, the infiltrometer were gently and vertically inserted into the soil about 5 cm. And, the insertion position ensured that the root collar was located in the center of the infiltrometer. We will add the required in formation in the revised version of the manuscript. And, we will add a picture of the permeameter ring as auxiliary material in the revised manuscript.

L.127 how did you proceed to remove the trees and shrubs?

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Response: Thank you for your suggestion. The above-ground parts of trees and shrubs were carefully removed to make them flush with the ground before the infiltration experiment. Meanwhile, the litter layer was carefully cleaned so that the soil surface was exposed. A more detailed description will be added to the revised manuscript.

how did you know which root system was underneath? how did you know whether was still alive or decaying?

Response: Thank you for your suggestion. Whether the root system is alive or decaying is determined by observing the growth situation of the aboveground part of the vegetation. The roots of plants with green leaves on the aboveground part and dead plants on the aboveground part are living roots and rotting roots, respectively. A more detailed description will be added to the revised manuscript.

L.128 the authors must explain and justify why a dye was used in this experiment. why dye was not applied to the outer ring? - also, is not the outer ring used as a buffer -i.e. The purpose of the outer ring is to have the infiltrating water act as a buffer zone against infiltrating water straining away sideways from the inner ring; so why different coloured water was employed.

Response: Thank you for your suggestion. Your comment is correct. The purpose of the outer ring is to have the infiltrating water act as a buffer zone against infiltrating water straining away sideways from the inner ring. During the experiment, the roots of the plants were almost entirely contained in the inner ring, while the outer ring was almost not. Methylene blue is an important tool to visualize preferential flow pathways and areas in soil profile as flow paths. Therefore, a mixed solution of water with Brilliant Blue was poured into the inner ring, and water without Brilliant Blue was added to the outer ring.

L.129 it is not clear/explained how much or to which level the rings were filled with water; were the rings refilled? if so, how? at what rate?

Response: Thank you for your suggestion. The prepared water is poured into the double-ring as fast as possible until the water depth reaches 5 cm, and the water level lines of the inner ring and the outer ring are kept consistent. We use the falling head method to measure the soil infiltration process. And, the time durations for the water line to drop 1 cm in the inner ring were recorded with a stopwatch until the infiltration time remains stable for three consecutive measurements. Then, water was refilled into the ring until the water depth reaches 5 cm whenever the water level dropped to a depth of 1 cm.

L.132 why?

Response: Thank you for your suggestion. Due to the rapid change of the infiltration rate in the beginning and in order to eliminate the influence of human measurement errors, we only use the average value of the infiltration rate in the first three minutes as the initial infiltration rate.

L.133 no results should be presented in this Section

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

L.135 if soil moisture was measured 24 h following infiltration, it is very likely that the authors measured the field capacity.

Response: Thank you for your suggestion. Soil gravimetric water content was measured by using a soil drilling method before infiltration measurement. And, we will add the required in formation in the revised version of the manuscript.

L.137 why 24 hours?

Response: Thank you for your suggestion. The excavation of the vertical soil profile was carried out on the second day or 24 hours after the end of the infiltration experiment in order to drain the infiltrated water.

L.138 the soil profiles are not shown in Fig. 1 - FIg.1 is showing drawings with annotations.

Response: Thank you for your suggestion. We will add relevant information about the soil profile in the revised version of the manuscript.

L.138 this step is unclear - more detail is needed - did you use a measuring tape, a gridded sheet + drawings, images...

Response: Thank you for your suggestion. I am sorry for my unclear description. The lateral width and vertical depth of the wetted volume were measured with a 1000 mm steel ruler with precision of 1 mm. And, a more detailed description will be added to the revised manuscript.

L.139 how did you identify the wetted area?

Response: Thank you for your suggestion. We used a digital camera to record the vertical profile to determine the extent of the wetted area. Meanwhile, the lateral width and vertical depth of the wetted volume were measured with a 1000 mm steel ruler with precision of 1 mm. We will add relevant information about the wetted area in the revised version of the manuscript.

L.140 why these depths?

Response: Thank you for your suggestion. The soil properties of the 0-50 cm soil layer are greatly affected by vegetation, so this study only measured and analyzed the soil properties of this layer. A more detailed description will be added to the revised manuscript.

L.142 did the authors measure soil moisture over time and carry out the experiment under different degrees of saturation? in my experience, preferential flow tends to be more significant near saturation but this has not been convincingly studied and deserves more attention. Could the authors address this point?

Response: Thank you for your suggestion. The soil moisture increases rapidly with the increase of infiltration time, and it is close to saturation at the later stage of infiltration. Therefore, studying the change of the steady-state infiltration rate can reflect the influence of preferential flow on soil infiltration rate when the soil moisture is close to saturation. And, we will add the required in formation in the revised version of the manuscript.

L.144 did the authors measured the particle density or was it assumed?

Response: Thank you for your suggestion. The particle density of this study refers to other studies of the same soil type as our experimental site. And, we will add the required in formation in the revised version of the manuscript.

L.147 how the root channels were identified? How many dimensions were used?

Response: Thank you for your suggestion. I am sorry for my carelessness. The root channel diameter and root channel area in the manuscript are root diameter and root area respectively. We will modify the relevant information about the root channels in the revised version of the manuscript.

L.148 why did the stubbles were measured?

Response: Thank you for your suggestion. Because the root diameter is determined by the measured diameter of the stubbles on the soil surface. The manuscript will be carefully revised to convey clear meaning.

L.149 it is hard to understand how the root channels in the inner ring were quantified/recorded

Response: Thank you for your suggestion. I am sorry for my carelessness. The root channel area in the manuscript means the root area. According to formula 3, the root area can be calculated by root diameter. And, the root diameter is determined by the measured diameter of the stubbles on the soil surface in the inner ring. We will modify the relevant information about the root channels in the revised version of the

manuscript.

L.152 this is very incomplete and does not provide enough info to understand the study and/or reproduce it.

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

L.158 why ANOVA, were the variables tested normally distributed? was this checked at all?

Response: Thank you for your suggestion. We will add relevant information about the test for the normal distribution of variables.

L.159 significance level is either 99 or 95 %

Response: Thank you for your suggestion. Significant level was 95%.

L.165 are these results shown anywhere in the MS? -e.g. Table or Figure>?

Response: Thank you for your suggestion. These results are shown in Table 1. And, we will add the required in formation in the revised version of the manuscript.

L.166 the variables need to be spelt out at the beginning of the Section, so the reader does not have to go back...

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

L.166 how the soil layers were divided? where is this explained?

Response: Thank you for your suggestion. Since the 0-10 cm soil layer is the first to contact water, the soil properties of this layer determine the initial infiltration rate. However, the steady infiltration rate is affected by the soil properties of 0-50 cm. Therefore, we consider the 0-10 cm soil layer as the top soil layer and analyze its soil properties. We will add the required in formation in the revised version of the manuscript.

L.175 this sentence is not clear. Also, where are these results shown?

Response: Thank you for your suggestion. The manuscript will be carefully revised to convey clear meaning. And, we will add the required in formation in the revised version of the manuscript.

L.175 this bulk density seems too high for vegetated soil...were the authors aware of any compaction or wetting-drying cycles which may be related to these levels of bulk density?

Response: Thank you for your suggestion. By carefully checking of the measurement data, we confirmed that the soil bulk density data is correct. In order to eliminate the influence of human trampling on the soil properties during fruit harvesting, we selected an abandoned fruit tree plantation for experimentation. There are no grazing animals in the fruit tree plantation (A. vulgaris). Therefore, there is almost no possibility of artificial compaction of the soil at this experimental site.

L.184 it is hard to digest these results -with respect to what the infiltration rate increased? was it higher under living or decaying roots? the authors must be very clear about the results and make sure the most relevant ones are highlighted.

Response: Thank you for your suggestion. I am sorry for my unclear description. The initial infiltration rate of alive roots of Armeniaca vulgaris increased by 48% compared with that of alive roots of Caragana korshinskii. However, compared with the decayed roots of Armeniaca vulgaris, the initial infiltration rate of the decayed roots of Caragana korshinskii increased by 37%. The sentence will be rewritten to convey clear meaning.

L.190 where are the results for ARCD and RCA shown?

Response: Thank you for your suggestion. These results are shown in Figure 4. And, we will add the required in formation in the revised version of the manuscript.

L.201 the text in this para belongs in the introduction

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion. And, the sentences will be moved to the introduction in the revised manuscript.

L.211 as it is not clear how ARCD and RCA were measured, nor the patterns of preferential flow, wetting area in the soil, these results are not very convincing. More detail is needed everywhere in this MS.

Response: Thank you for your suggestion. I am sorry for my carelessness. We used a digital camera to record the vertical profile to determine the extent of the wetted area. Meanwhile, the lateral width and vertical depth of the wetted volume were measured with a 1000 mm steel ruler with precision of 1 mm. The root channel diameter (ARCD) and root channel area (RCA) in the manuscript are root diameter and root area respectively. According to formula 3, the root area can be calculated by root diameter. And, the root diameter is determined by the measured diameter of the stubbles on the soil surface. Preferential flow means that soil receives replenishment on the entire inflow boundary, but moisture and solute bypass the soil matrix and move quickly through a small part of the soil. Preferential flow formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). We will modify the relevant information about the root channels in the revised version of the manuscript. And, a more detailed description will be added to the revised manuscript.

L.212 was macropore flow explicitly measured?

Response: Thank you for your suggestion. Although we did not accurately measure the absolute value of macropore flow in different treatments, we can calculate the relative change of macropore flow. For example, macropore flow of the decayed root increased 41% compared to the alive roots when the diameter of the roots was similar in the C. korshinskii (Fig. 4a). Because macropores formed by decayed roots could make the soil water more easily and faster into the deeper layers of the soil.

L.214 this is not clear nor why it is environmentally relevant.

Response: Thank you for your suggestion. Our results provide a clear evidence that the decayed root systems of a shrub species (Caragana korshinskii) and a fruit tree species (Armeniaca vulgaris) act as preferential flow channels for increasing soil water infiltration into soil. The macropore flow formed by the root channels is considered to be the main effect factor on preferential flow (Weiler and Naef, 2003). Preferential flow formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, Macropores formed by decayed roots are conducive to the restoration of soil moisture in arid areas, thereby mitigating the aggravation of the dried soil layers. And, we will add the required in formation in the revised version of the manuscript.

L.219 any ideas why? this needs to be explained further

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

L.221 which one is this? did you mean formation of perched water tables? - again this text seems to belong in the Introduction.

Response: Thank you for your suggestion. The manuscript will be carefully revised to convey clear meaning. And, the sentences will be moved to the introduction in the revised manuscript.

L.224 where is this shown?

Response: Thank you for your suggestion. I am sorry for my carelessness. The manuscript has been revised as follows to convey clear meaning. After aggregating our field measurements with the previous research findings (Guo et al., 2019), we found that the difference in infiltration rates between dead and living roots is the largest in scrubland species (C. korshinskii), followed by the fruit tree (A. vulgaris) and Herbaceous species (Medicago sativa) (Fig. 4).

L.226 the purpose of using a dye is not explained - nor the results shown.

Response: Thank you for your suggestion. Methylene blue is an important tool to visualize preferential flow pathways and areas in soil profile as flow paths. These results are shown in Figure 1. And, we will add the required in formation in the revised version of the manuscript.

L.230 i presume that there is a long list of studies reporting similar findings? however these are not listed anywhere

Response: Thank you for your suggestion. We will add the required in formation in the revised version of the manuscript.

L.232 steady and transient infiltration has not been defined or introduced It would be good that the process of infiltration and theories such as Norton or Green & Ampt were at least overviewed or mentioned to place this study in context.

Response: Thank you for your suggestion. A stopwatch was used to record the infiltration time until there was no change in the infiltration time for three consecutive measurements, and the rate was assumed to be steady infiltration rate. We will add the required in formation in the revised version of the manuscript.

L.233 'The' results

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

L.234 these results have not been presented in Section 3

Response: Thank you for your suggestion. We fully agree with this comment and we will add the relevant content of Figure 5 to the results section in the manuscript.

L.237 not clear how the findings gathered here can help to shed light on this.

Response: Thank you for your suggestion. Our results provide a clear evidence that the decayed root systems of a shrub species (Caragana korshinskii) and a fruit tree species (Armeniaca vulgaris) act as preferential flow channels for increasing soil wa-

ter infiltration into soil. The macropore flow formed by the root channels is considered to be the main effect factor on preferential flow (Weiler and Naef, 2003). Preferential flow formed by decayed roots may ease soil water to move down to deep soil layers, especially in dried areas (Bogner et al., 2010). Hence, Macropores formed by decayed roots are conducive to the restoration of soil moisture and the sustainability of vegetation restoration in drylands. And, we will add the required in formation in the revised version of the manuscript.

L.239 study limitations or future work not mentioned also the study is not framed in the wider body of international studies...

Response: Thank you for your suggestion. Your suggestions were very helpful in making a better manuscript. And, we will add the required in formation in the revised version of the manuscript.

L352 Fig. 4 the results are good but they seem obvious/trivial - i.e. it is well know that plant roots contribute to increase soil infiltration - macropores, structure changes, etc. have been widely reported. I am not familiar with many studies looking into decayed and living roots - yet i remember well a study from 2013 published in EcolEng by Federico Preti- Forest protection and protection forest: Tree root degradation over hydrological shallow landslides triggering. Ecological Engineering

Response: Thank you for your suggestion. Although previous studies have addressed the effects of root systems on soil water infiltration, the effects of root channel formed by decayed roots after vegetation die off on soil water infiltration and soil water storage are still not clear. Meanwhile, most studies have concentrated the research on one plant type or species (Wu et al., 2016; Jiang et al., 2018; Guo et al., 2019), neglecting the comparison between different plant types. Therefore, this study explores the effects of decayed and alive roots on soil infiltrability in three common vegetation types (shrubs, fruit trees, and herbs) in semi-arid regions, and determines the contribution of the preferential flow to soil water. The results of this study indicate that the preferential

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flow formed by decayed roots is beneficial to the restoration of soil moisture and the sustainability of vegetation restoration in drylands. And, a more detailed description will be added to the revised manuscript.

figure caption is behind the figure so it cannot be read

Response: Thank you for your suggestion. We will modify the text following the reviewer's suggestion.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-266, 2020.

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