Responses to the Comments by the Reviewer

(1)This study investigates the potential of leaf water uptake of Tamarisc in an arid region in China by i) evaluation of reverse sapflow measured in shoots, branches and stems; and ii) by weighting leaf mass before and after drying, prior and post precipitation events, and using the difference in weight as a proxy for leaf water uptake. The results are promising; the manuscript, however, lacks some structure and consistency.

Response: We thank Editor and an anonymous reviewer for their constructive comments. Based on your comments, we have made extensive modification on the original manuscript and restructured the paper to improve the consistency. Specifically, we have adjusted the research methods and discussion to avoid repetitive and unnecessary description. We have also made efforts to improve the writing.

(2) Along with the annotations and comments I made throughout the manuscript, I want to point out some key aspects where improvement is needed. The authors consider two conditions under which water can be taken up by the leaves. These are i) uptake of water when relative humidity is greater than a certain threshold, and ii) uptake of water when precipitation occurs. These 2 processes are not mutually exclusive, given that i) during precipitation, the relative humidity normally is at high levels, and ii) during high relative humidity conditions without precipitation, droplets of water might still occur on leaves and mimick the presence of precipitation. This raises the question whether distinguishing these 2 conditions is meaningful in the first place. Like the authors, I agree that isolating the 2 conditions is good practice, but throughout the manuscript this distinguishment is not consistent and sometimes confusing (multiple terms describing similar things are used + the structure of the manuscripts does not always reflect this distinguishment). I would like to see clear results where leaf water uptake is occurring under the two conditions, which allows meaningful interpretation and comparison.

Response: Thanks for this valuable comment. We have revised the text to clearly state the aims of our research in the introduction. We assume that transpiration ceases during the precipitation event and the relative humidity (RH) of the air reaches 100%, a presumption that has been supported by many previous field experimental observations. The first step in our experiment was to demonstrate that Tamarisk leaves absorb atmospheric vapor under high RH conditions, and the experiment results demonstrated that Tamarisk leaves absorbed atmospheric vapor if the RH was greater than 75%. This suggests that the leaves certainly absorb atmospheric vapor during the precipitation period when RH is close to 100%. Second, we dried and weighed the

leaves samples to calculate the amount of atmospheric vapor that was absorbed by the leaves. Third, we recorded the duration of precipitation, including light precipitation which was defined in the introduction. As we collected Tamarisk leaves for weighing before and after the artificial precipitation experiment and dried them afterward to calculate the moisture content of the leaves, then the percentage of precipitation absorbed by the leaves can be computed. Overall, our objective was to investigate the absorption of precipitation by Tamarisk, so we did not quantify the absorption of atmospheric vapor by Tamarisk leaves under non-precipitation conditions with high RH. The process of absorption of unsaturated atmospheric vapor by Tamarisk will be a subject of future investigations.

(4) The discussion part could benefit from some additions, I made some suggestions in the manuscript. Also,in the results section the authors already discuss, try to keep results and discussion separate. I have a feeling that key results should be highlighted more in the text and that headlines could be more specific. I would change the order of the presented results. I would put figure 7 and the corresponding section very early in the results, because it shows nicely a lot of key findings. I would consider to stick at either RH or VPD, or make it more clear why you need both.

Response: Thank you for your careful review and very important suggestion. We have moved Figure 7 and the associated results to the first paragraph of results. We decided to remove VPD as an indicator and we will analyze the results based entirely on RH.

(5)I would like to read a more distinct paragraph on the potential mechanisms leading to leaf water uptake. I'm sure there is lots of research on the subject. You do have it in the manuscript, but it is short and not really describing the mechanisms or theory behind.

Response: Implemented. We have added the fundamental process of atmospheric vapor absorption by leaves and the status of related research in the discussion section, please see section 4.1 with the following sentences: “How plants absorb atmospheric vapor is still an open question. At the plant scale, there are two pathways for the vegetation to uptake atmospheric vapor (Liu et al., 2021). First, atmospheric vapor condenses and infiltrates into the root soil layer for uptake. Second, plants uptake atmospheric vapor through the leaves. The isotopic tracer experiments have showed that $\delta^{18}O$ in specially designed artificial precipitation event was found in the plant stems, suggesting that leaves can absorb the atmospheric vapor during precipitation events (Hill et al., 2021). At the leaf scale, there are three possible pathways for atmospheric vapor to enter the leaf (Zhang et al., 2019). First, when plant leaves breathe and the stomata is open, vapor can enter the leaves. Second, when precipitation event happens, atmospheric water pressure is below leaf water pressure, thus water enters the leaf through

membrane, driven by the water pressure gradient. Third, there are some hydrophilic proteins on the cell surface and these protein channels can absorb water and transport the absorbed water into cells. How the three pathways work is not exactly clear at present (Zhuang et al., 2021)."

All the issues that should be corrected in the revised version are listed as follows:

1. Line 18, the word "plants" is replaced with "of a plant".
2. Line 19, we have added a brief sentence to describe the experiment: "to study desert plants absorb atmospheric water vapor".
3. Line 24, the long sentence is replaced with two short sentences. "The results showed that when precipitation occurs, Tamarisk directly absorbs precipitation water, and the main stem, lateral branch, and shoot all show the signs of reversed sap flow, which accounted for 21.5% of the annual sap flow in the shoot and branch, and 13.6% in the stem"
4. Line 30, the word "absorb" is replaced with "absorb water from the"
5. Line 31, we have revised the vague descriptions: "even the absorbed atmospheric water vapor was transported from the leaves to the stem, forming a reversed sap flow".
6. Line 36, the word "the" is replaced with "an".
7. Line 42, all citations are preceded with a space.
8. Line 44, we have deleted the word "body system".
9. Line 45, we have deleted the word "system".
10. Line 45, the word "moved" is replaced with "move".
11. Line 46, we have revised the sentences to describe the experiments and conclusions clearly. "The gradient of water potential from the soil to the roots, and then to the leaves drives water uptake and transport by plants".
12. Line 48, the word "could" is replaced with "can".
13. Line 51, we have deleted "thus".
14. Line 53, the word "of" is replaced with "in".
15. Line 54, the word "when" is replaced with "on".
16. Line 54, We have deleted "appears, the liquid"
17. Line 57, the word "column adheres" is replaced with "condenses and adheres".
18. Line 58, the word "that" is replaced with "where".
19. Line 60, the word "have shown" is replaced with "has shown".
20. Line 60, we have added the word "transport of".
21. Line 61, we have added the citation of (Schreel and Steppe, 2020).
22. Line 63, we have revised the sentences: "Water transport in plants also relies on water potential gradients in plant tissues and organs".
23. Line 67, the word "could" is replaced with "can".
24. Line 68, the following paper was cited: "Berry, Z. Carter, et al. "Foliar water uptake:

processes, pathways, and integration into plant water budgets." Plant, cell & environment 42.2 (2019): 410-423."

25. Line 68, we have deleted the word "have".
26. Line 71, we have revised the sentences accordingly.
27. Line 85, the word "increasing evidence" is replaced with "further studies".
28. Line 88, we have used word "however" here because previous sentence describes the finding that strong precipitation pulses have a significant effect on desert plant, but the literature cited in this sentence shows that light precipitation has a significant effect on desert plant.
29. Line 88, the word "researches" is replaced with "research"
30. Line 91, we have revised the sentences as "but not address the issue of direct absorption of precipitated water through the leaves".
31. Line 91, we have revised the sentences as "We have designed a sequence of multi-year in-situ experiments in a selected arid region in Northern China".
32. Line 94, the word "could" is replaced with "can".
33. Line 97, the word "dose" is replaced with "can".
34. Line 104, the word "in" is replaced with "at".
35. Line 105, the word "on" is replaced with "at".
36. Line 128, we have revised the sentences as "The main species of vegetation in the field site is primarily (about 80%) native Tamarisk ramosissima, and the remaining vegetations are Haloxylon ammodendron and Hedysarum scoparium"
37. Line 130, we have deleted "and so on", and use "et al." instead.
38. Line 136, we have explained the mismatch between native plants and cultivated vegetation: "Shallow root systems indicate that cultivated vegetation depends on the use of atmospheric water rather than groundwater".
39. Line 148, we have redrawn figure 2 to improve its quality, as shown below.

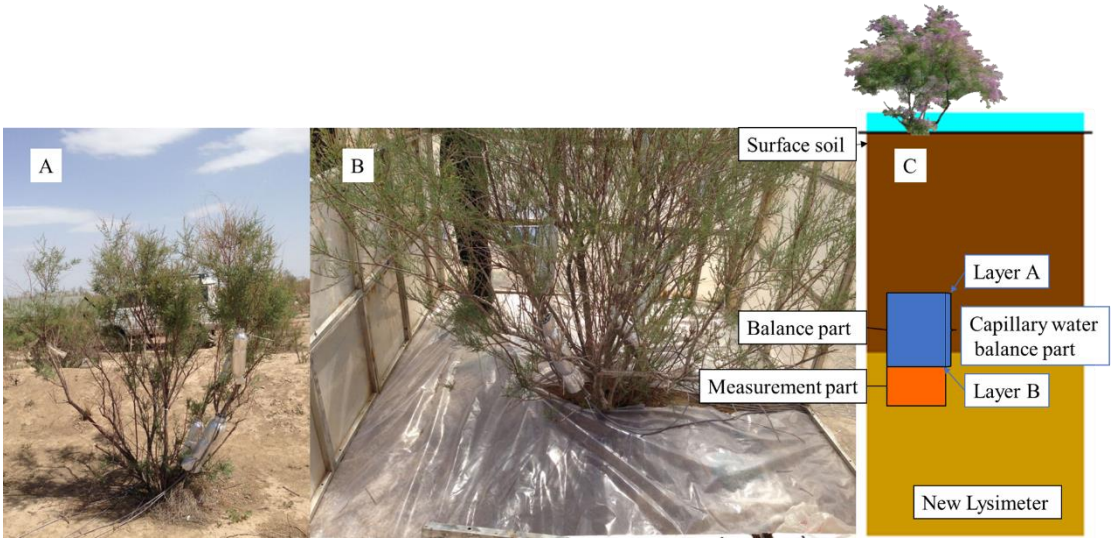
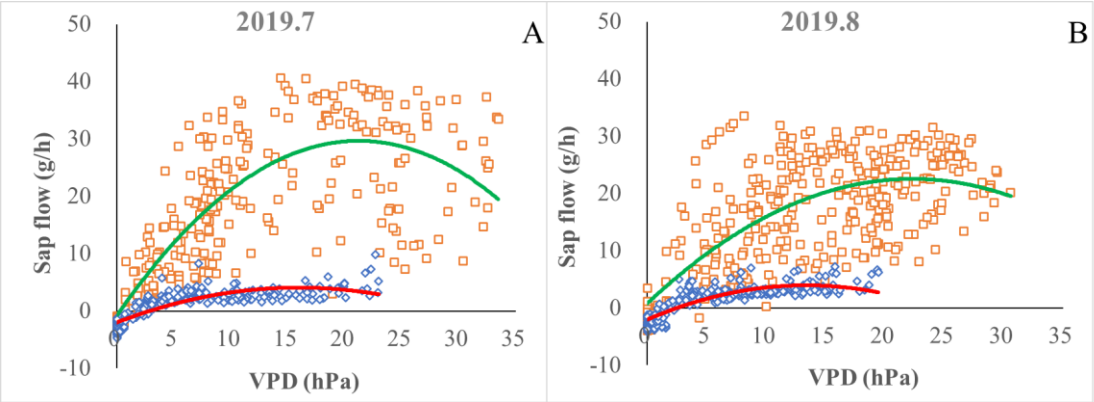


Figure 2. A) This picture shows the in-situ Tamarisk, with sap flow probes wrapped on the main stem, lateral branches, and shoots. B) The figure shows the experimental setup, with the Tamarisk placed in a semi-enclosed transparent controlled-climate room, where artificial precipitation experiments can be carried out closed for atmospheric water vapor absorption experiments. C) the new lysimeter, with a balance part and a measurement part.

40. Line 162, we have deleted "the and state".
41. Line 169, a sentence introducing the equation is added, "The water balance equation (1,2,3) is shown below".
42. Line 175, the sentence is revised as "R=0, and there is no runoff in the plot".
43. Line 185, we have deleted the sentence of "roughly represent the stand structure at the site".
44. Line 188, we have revised the sentence with "thermistor needles".
45. Line 195, we have explained $Vsap$: $Vsap$ is sap velocities, the units is m/s.
46. Line 210, we have rewritten the sentences
47. Line 215, we have revised the sentences as "In this research, we define the atmospheric relative humidity (RH) at which Tamarisk leaves start to absorb atmospheric water as the critical condition. We also assume that this critical condition is met when reversed sap flow is observed".
48. Line 220, we have deleted word "to" and revised the sentence as "when Tamarisk absorbs …".
49. Line 231, we have revised the sentence as "the sap flow at the measuring location".
50. Line 232, we have revised this sentence as "However, when the leaves absorb atmospheric vapor for replenishing the leaf cells, this part of absorbed water will not be transported to the stem through the monitoring point, so this part of absorbed water will not be monitored, leading to a small monitored sap flow".

51. Line 240, SF is sap flux at a certain time.
52. Line 245, this sentence is revised as “we cut down the whole Tamarisk, and the branches with installed sap flow meters are collected and weighted”.
53. Line 246, condensation indeed will recharge vegetation as well. However, our aim is to uncover the water uptake of atmospheric vapor by leaves, so we exclude condensation in our investigation.
54. Line 255, we have deleted “the moisture”.
55. Line 260, the reason for us to monitor the sap flow for a week per month is as follows. We have built a room to control the humidify, and we find out (after several failures) that the control room will increase the temperature inside the control room and the elevated temperature can kill the plant. Therefore, we carry out our experiment only at night, a week for a month. For the rest time when the artificial precipitation experiments are not conducted, the control room is open to the atmosphere so the room temperature remains the same as the native environment.
56. Line 277, here we have measured the water content changes in the leaves. This is because we like to confirm that the sap flow data are accurate, so we have sampled the water content changes of leaves before and after the humidification.
57. Line 290, we have revised “or films of water over” to “on”.
58. Line 291, we have revised the sentences to describe the experiments clearly. “In this study, we have counted the sap flows in the shoot, branch and stem”.
59. Line 292, We have proposed this hypothesis for VPD to determine the amount of water in the air versus the maximum amount of water vapor that can exist in the air. When the water stress is greater, vegetation needs more water and leaves needs to absorb more water.
60. Line 299, we have deleted this sentence.
61. Line 301, we have revised the sentences as “we find that the day and night sap flow rates of Tamarisk vary significantly”.
62. Line 301, we have deleted “may be”.
63. Line 305, we have used “2 hours” instead of “some moments”.
64. Line 317, we have used “observed” instead of “formed”.
65. Line 318, this research is aimed to investigate rainfall uptake by desert vegetation. A humidification experiment has been carried out to see if desert vegetation absorbs atmospheric vapor and our experiment has confirmed that desert vegetation indeed absorbs atmospheric vapor. After that, we can calculate the amount of atmospheric vapor absorption based on the duration of precipitation event.
66. Line 319, we have revised this sentence as “to determine the critical condition at which”.
67. Line 323, we have used “which zeros” instead of “isolating”.

68. Line 324, we have used “avoids” instead of “avoiding”.
69. Line 337, we have moved this sentence to the methods Section. See line 219.
70. Line 339, we have revised this sentence as “As shown in Figure 5, we carried out three humidification experiments and found that when the RH reached 75%, reverse sap flow was observed”.
71. Line 342, we have conducted several artificial precipitation experiments and found that the reverse sap flow was observed on the sap flow meter when the control room RH reached 75%, so we came to the conclusion that a RH of 75% was the tipping point at which the reverse sap flow occurred, as shown in Figure 5.
72. Line 346, we have revised this sentence as “To confirm that the reverse of sap flow in Tamarisk appears at high RH conditions, we have humidified the other two controlled Tamarisk: one at low humidifying intensity with a controlled RH of 75%, and the other at high humidifying intensity with a controlled RH above 90%”.
73. Line 351, we have revised this sentence as “This is a piece of evidence of Tamarisk leaves absorbing atmospheric vapor under a relatively high humidity condition. However, we are unable to determine whether the absorbed water moisture originates from atmospheric vapor, or it comes from water expelled from leaves and transferred to stems, thus forming a reverse sap flow. Therefore, we need to sample and measure the water content of leaves to determine whether they are absorbing atmospheric vapor or not.”
74. Line 353, we have performed the humidification process only at night. This is because the daytime temperatures in the field site (desert) are too high, especially inside the control room, and the greenhouse effect kills the plants quickly. Therefore, we chose to carry out the humidification experiment at night when it is cooler.
75. Line 369, we have define light precipitation in the methods section as precipitation of less than 5 mm/d.
76. Line 370, we have used “does” instead of “do”.
77. Line 372, we have deleted the word “the”.
78. Line 373, we have used “are” instead of “have been”.
79. Line 389, we have deleted this sentence.
80. Line 391, we have used “predicts the” instead of “prediction to”.
81. Line 396, we have addressed this in the Discussion.
82. Line 400, we have redrawn this figure.



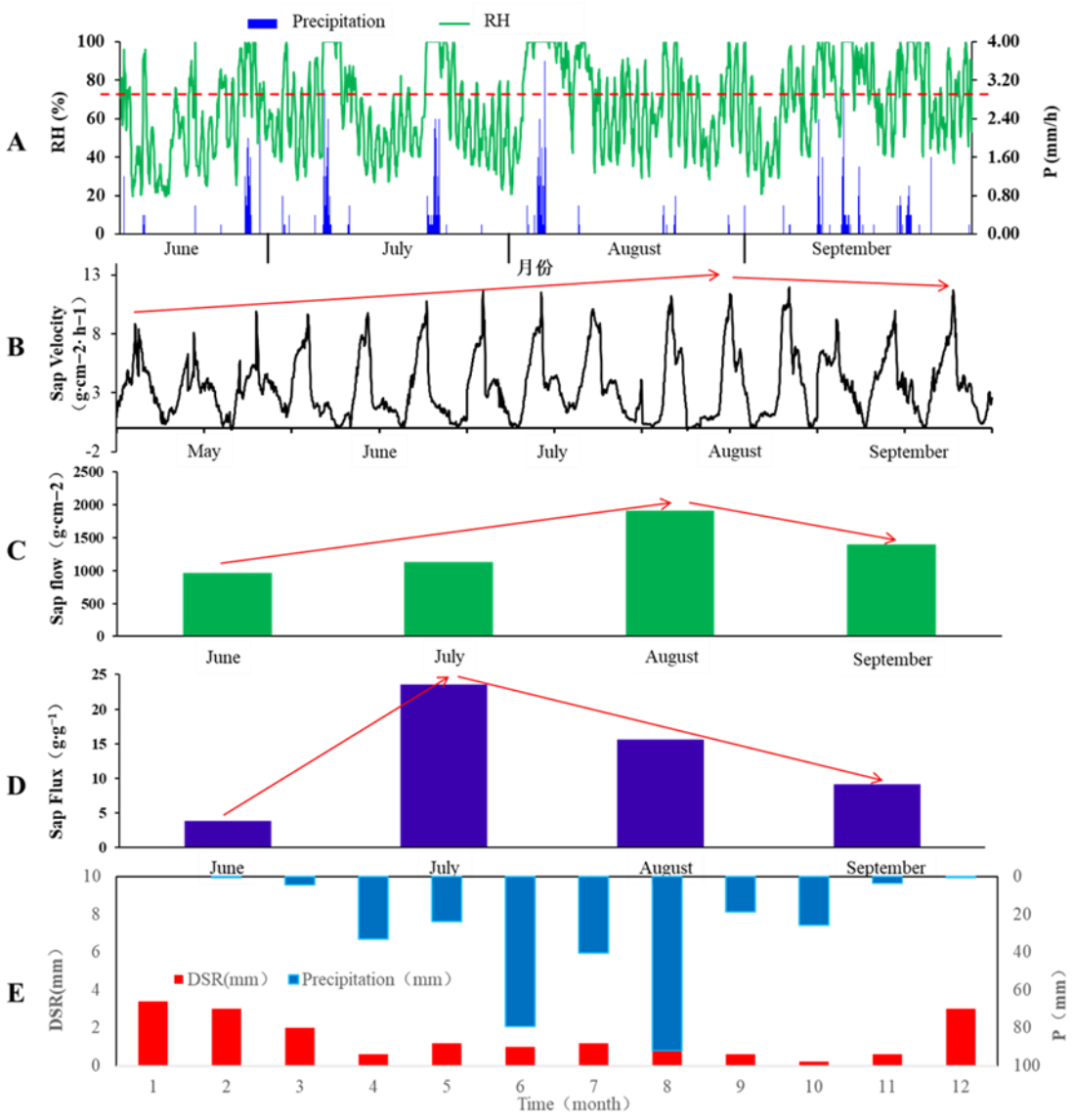
83. Line 408, we have used “As depicted in” instead of “According to”.
84. Line 410, we have used “tends” instead of “tended”.
85. Line 411, we have revised this sentence as “reaching saturation levels and formation of dew”.
86. Line 417, we have used “period” instead of “date”.
87. Line 419, we have revised this sentence as “By investigating”.
88. Line 420, we have used “can” instead of “could”.
89. Line 421, we have deleted “any”.
90. Line 427, we have used “period” instead of “date”.
91. Line 428, we have deleted the unnecessary sentence.
92. Line 429, we have revised the long sentences and used short sentences as “In this study, we first observed the phenomenon of reverse sap flow in Tamarisk in the control room under humidified conditions, and then, through in situ experiments, we sampled the leaves to calculate the precipitation absorption by the leaves”
93. Line 433, we have deleted “a” and used “the branches” instead of “branch”.
94. Line 434, We delete “was” and “influenced”.
95. Line 439, this sentence has been rewritten as “light precipitation can be absorbed by Tamarisk leaves”.
96. Line 439, we have used “A” instead of “there is”.
97. Line 440, we have deleted “occurred”.
98. Line 441, this sentence has been revised as “caused no remarkable reversed sap flow”.
99. Line 443, this sentence means that 0.5% of precipitation entered the stem and 1.1% entered the branch.
100. Line 449, we have added “only” here.
101. Line 452, we have revised this sentence as “There was a continuous precipitation event (more than 12 hours) occurred on the 27th, July 2019”.
102. Line 453, we have deleted “the”.
103. Line 454, we do not have sufficient data to analyze the effect of the light precipitation

duration on the reverse sap flow, so here we only speculate that the duration of precipitation affects the reverse sap flow.

104. Line 456, Implemented.

105. Line 460, in this study we investigated the tipping point of the reverse sap flow by controlling the changes of atmospheric RH in a control room, we found the tipping point at RH of 75%, meaning that when the atmospheric RH value was above 75%, the absorption of water by Tamarisk leaves was recorded by the sap flow meter. During the light precipitation events, the atmospheric RH was certainly much higher than 75%, and very close to 100%, so we can calculate the uptake of light precipitation by Tamarisk based on the length of such precipitation events.

106. Line 484, we have redrawn figure 9.



107. Line 466, we have revised this sentence as "As shown in Figure 9, Tamarisk water consumption peaks in August, but the highest solar radiation in the area is in July, we have

found that July has the most precipitation events, and the large amount of precipitation in July may recharge Tamarisk through leaves and delay the peak of transpiration that should occur in July until August."

108. Line 471, we use "as" instead of "As".

109. Line 472, we have rewritten this sentence as "DSR is rare in these months, probably because June to August is the growing season for Tamarisk and most of the precipitation is absorbed by plants or returned to the atmosphere through evaporation."

110. Line 475, we have moved this sentence to the beginning of the paragraph.

111. Line 477, we have defined "light precipitation" as "We define light precipitation as a daily precipitation below 5 mm".

112. Line 478, implemented.

113. Line 482, we have revised these sentences to describe the experiments clearly as "As Tamarisk can absorb atmospheric vapor through its leaves, we can speculate that Tamarisk was able to mitigate its water need by taking water from multiple means such as leaves and soil."

114. Line 489, we have revised this sentence as "Whether desert areas plants can actively absorb atmospheric vapor is still a debated issue".

115. Line 492, we use "fog" instead of "clouds".

116. Line 493, this sentence has been rewritten as "The potential for absorbing unsaturated atmospheric water was believed to be difficult".

117. Line 497, this sentence has been rewritten as "we found that the leaves were able to absorb the unsaturated atmospheric vapor if RH was above 75%".

118. Line 499, this sentence has been rewritten as "These findings confirm that Tamarix leaves in the arid regions have multiple means of obtaining water."

119. Line 504, implemented.

120. Line 506, implemented.

121. Line 509, we have rewritten this sentence as "Whether it is day or night, transpiration and photosynthesis will cease when precipitation events occur, this is an excellent opportunity for plant leaves to absorb atmospheric vapor(Schreel et al., 2019). Studies have found that fog lasting longer than 2 hours in arid zones can also be absorbed by plant leaves (Steppe et al., 2018)."

122. Line 513, we have rewritten this sentence as "Study also found that a longer precipitation events not only produced a significant reversed sap flow, but also yielded a high absorption ratio of precipitation by leaves(He et al., 2020)".

123. Line 524, we have used "condensation" instead of "condensate".

124. Line 527, we have deleted "or not".

125.Line 532, we have moved this paragraph to the results section.

126.Line 541, we have moved this paragraph to the introduction, see line 94-100.

127.Line 549, we have moved the definition of light precipitation to the introduction.

128.Line 558, this result is shown in table 2, last line of summary part.

Reference

[1] Liu, Z., Zhang, H., Yu, X., Jia, G., and Jiang, J.: Evidence of foliar water uptake in a conifer species, Agricultural Water Management, 255, 106993, 2021.

[2] Hill, A. J., Dawson, T. E., Dody, A., and Rachmilevitch, S.: Dew water-uptake pathways in Negev desert plants: a study using stable isotope tracers, Oecologia, 196, 353-361, 2021.

[3] Zhang, C., Li, X.-Y., Wang, Y., Wu, H., Wang, P., Li, W., Bai, Y., Li, E., Wang, S., and Miao, C.: Responses of two desert shrubs to simulated rainfall pulses in an arid environment, northwestern China, Plant and Soil, 435, 239-255, 2019.

[4] Zhuang, Y., Zhao, W., Luo, L., and Wang, L.: Dew formation characteristics in the gravel desert ecosystem and its ecological roles on Reaumuria soongorica, Journal of Hydrology, 603, 126932, 2021.

[5] Schreel, J. D. and Steppe, K.: Foliar water uptake in trees: negligible or necessary?, Trends in plant science, 25, 590-603, 2020.

[6] Schreel, J. D., Van de Wal, B. A., Hervé-Fernandez, P., Boeckx, P., and Steppe, K.: Hydraulic redistribution of foliar absorbed water causes turgor-driven growth in mangrove seedlings, Plant, Cell & Environment, 42, 2437-2447, 2019.

[7] He, Q.-Y., Yan, M.-J., Miyazawa, Y., Chen, Q.-W., Cheng, R.-R., Otsuki, K., Yamanaka, N., and Du, S.: Sap flow changes and climatic responses over multiple-year treatment of rainfall exclusion in a sub-humid black locust plantation, Forest ecology and management, 457, 117730, 2020.