Biogeosciences
Discussions

Interactive comment on "Root uptake under mismatched distributions of water and nutrients in the root zone" *by* Jing Yan et al.

Anonymous Referee #1

Received and published: 2 June 2020

The manuscript entitled "Root uptake under mismatched distributions of water and nutrients in the root zone" aims to test how mismatched distribution of water and nutrient influence nitrogen acquisition and plant growth. The authors further investigate how hydraulic redistribution and changes in root morphology can explain their results. While the objective of the study is very relevant and rather clearly defined and justified, the rest of the manuscript (material and methods, results, discussion and conclusion) is hard to follow, with crucial elements lacking from the material and methods. It makes it difficult to understand why the authors did some measurements and what they really measured. In the discussion and conclusion, I found some part too speculative. For example, how could you conclude so strongly about the crucial role of root hairs and production of mucilage, only based on non-quantitative microscopic observations? I

suggest you better describe what you really demonstrated and what your results only suggest. Overall, I think that the data provided here are of good quality, that the design was well though, but the manuscript is poorly written. See specific comments to help you to improve it.

Abstract:

Please precise which plant (or at least type of plant) you grew as I am not sure that trees, herbs and grass shows the same adaptations to mismatches. At least, it should be proven before concluding it. We lack the experimental design (at least briefly mentioned) in the abstract

l.13 -15 : It is too strong from my perspective. You did not quantified root hair density, neither production of root mucilage.

Introduction:

l. 28 -31 : I was pleased to read that you mention the role of rhizospheric soil microbes to make nutrients available for plants. This could, and for my perspective should, be mentioned in the discussion too (although not too extensively as you did not measured any microbial parameter here).

You mention specific adaptations of plants to water or nutrient deficiency (or heterogeneous distribution), namely: (i) Preferential growth in moist areas and modifications of root exudation (l.32-36) and hydraulic redistribution (l. 38 – 42). In these two paragraphs, you develop more adaptations to water scarcity or heterogeneity in fact. Adaptations to N deficiency or heterogeneity are less developed. For example, roots of a non-legume plant can forage toward the roots of a legume plant (Weidlich et al., 2018). Associations with soil microbes, such as N-fixing bacteria and mycorrhizae are as well strategies to enhance N acquisition and avoid growth limitations. Differences in root morphology (SRL, ratio root length/dry mass) of absorptive roots are typically used to describe foraging behavior of roots to acquire root N (a mobile nutrient). Proliferation

of root hairs (which is not mentioned here, although it seems to be important for your article), or root clusters (highly branched roots) are more known to enhance acquisition of P, a less mobile element often found in patches (Lambers et al., 2011; Bates et al., 2001). With regards to adaptations of roots to water scarcity, see as well the recent article from Bristiel et al., (2019). The adaptations cited here do not sufficiently cover the topic.

Weidlich, E. W., Temperton, V. M., & Faget, M. (2018). Neighbourhood stories: role of neighbour identity, spatial location and order of arrival in legume and non-legume initial interactions. Plant and Soil, 424(1-2), 171-182.

Lambers, H., Finnegan, P. M., Laliberté, E., Pearse, S. J., Ryan, M. H., Shane, M. W., & Veneklaas, E. J. (2011). Phosphorus nutrition of Proteaceae in severely phosphorus-impoverished soils: are there lessons to be learned for future crops?. Plant Physiology, 156(3), 1058-1066.

Bates, T. R., & Lynch, J. P. (2001). Root hairs confer a competitive advantage under low phosphorus availability. Plant and Soil, 236(2), 243-250.

Bristiel, P., Roumet, C., Violle, C., & Volaire, F. (2019). Coping with drought: root trait variability within the perennial grass Dactylis glomerata captures a trade-off between dehydration avoidance and dehydration tolerance. Plant and soil, 434(1-2), 327-342.

l. 50 – 53: While the objective was rather clearly described, I do not see the point with these last sentences.

Material and methods

In general, this section lack clarity and there is several important missing information. The methods are often described without explaining their aim. The subsection 2.1 (which could be renamed experimental design) lack to present the experimental design. Instead, the signification of treatment D, C1 and C2 is given at the beginning of the results! I can't find figure S1. I lack as well the number of replicates. The duration

of the experiment should be given here too. The quantities of N, water, how are loss compensated, where it is added should be described... please report what was done with accuracy.

l.62 – 67: the measurement of water content and water potential belong to plant and soil characterization

l. 80: Please define NUE, I guess this is nitrogen use efficiency, but this should be written.

l. 86: What do you mean by "further gravimetric measurements"?

l.88-93: It is not clear why you are doing these microscopic analyses. Why laser of two different wavelengths are used? What is gold coating for?

Results

The subsections are confusing. Is plant water and nutrient uptake (3.3) not related to plant physiology (3.1)? Please reorganize. Moreover, some parts belong to material and methods, other to discussion. Focus on what you have observed here.

l.105 – 115: This belongs to material and methods.

l. 118 -120: This is your interpretation of the results. It should go to discussion.

l.122 -124: This belongs to introduction

l. 127: How did you test that root density do not differ between the two compartments? By comparing root masses? If this is the case, it is thus not root density but root mass. Moreover, in table A2, the wet and dry compartments of the treatment D are significantly different.

l. 127- 128 : this belongs to material and methods

l. 130-131: Belongs to material and methods

l.131- 134: Please indicate what this higher root masses in the deeper part suggests

in the discussion. Here you should describe the results.

l.135: Again root density or root mass?

l.136- 138: again, belong to discussion. Moreover, avoid detailing twice the same idea. An increase in root mass in the deeper layer is seen in the three treatments D, C1 and C2.

l. 138- 140: This should be stated in material and method, not here.

l.140: Did you measure root growth? Or are you indicating root mass? Root mass is not equal to root growth as the root mass at a given point depends on root growth, and root death (life span / root turnover).

l.143. 145 from "which is…" belongs to discussion.

l.146: How did you measure root hair density? What test did you do to conclude for significant differences?

l. 147 – 148: This belongs to discussion

l.150: Avoid starting a new paragraph with "the above observations". It suggest you are still developing previous ideas, so why starting a new subsection?

l. 151 – 153: Belongs to introduction

l.155: Did you describe the frequency of the irrigation?

l. 157: The information about the frequency of N addition should be given in material and method.

l.161: How did you converted soil water potential data to rhizosphere water content?

l. 163-164: Avoid opinion terms such as " closer inspection".

l.166: Do no cite literature in the results, you should describe what you found here.

l. 168: What do you mean by "habitable environment"? For the roots? For rhizospheric

microbes? Your focus here is not nutrient uptake, please stay stick to it.

l. 173 -175: Again, this is not the description of the results.

l. 176 – 179: This belongs to discussion

l. 180: Do you assume that the organic coating is root mucilage? How did you quantified it? What are the two fluorescent wavelength for?

L.181: keep suggestion to the discussion

l. 181: This is an interpretation, not a result.

Discussion

l. 184 – 186: This belongs to introduction

l.192: How could you confidently conclude that plant performance are less sensitive to localized scarcity in water and N if nutrient and water are sufficient in other locations where the roots forage. You did not tested it. To know it you should have a mismatched distribution of water and nutrients, with an overall limitation in water and N (compared to your treatment D).

l. 194: I can't see what allow you to draw this conclusion here. Nothing written in the paragraph above allow to conclude it, although I think that you are right to point different plant strategies in case of mismatches.

l. 197 – 198 : Sentence not clear

l. 198 : You did not measure root proliferation as far as I have understood and what do you mean by this term: root growth? Root turnover?

L.199: What is multi-scale signaling and feedback? This is too vague.

l. 200: You did not describe root allocation in the results. You surely want to say that this is the relative mass of roots in the two compartments? Or in the various depths? Please specify it. I can't see how it points a whole plant scale regulation of root growth.

Please explain.

l. 201: This confirms the foraging behavior of non legume roots to legume roots (Weidlich et al. 2018).

l. 204 – 205: This is one of the most interesting result of the study. Please detail more.

l. 206: What do you mean by "vigorous"? How did you measure it? It is not clear to me how drying after wetting event can indicate vigor.

l.214: This is an important result too.

l. 218 -219: What do the references refer to? You conclude here from your own results and cite the related figure. I guess the references indicate that this has been previously shown?

l.221: Need a reference

l. 226 – 229: Avoid finishing with limitations. Specify them either in the conclusion or in the discussion but not at the end as this is the last take home message for the reader.

Conclusion:

L.231: "could" or "did"? Be clear with what you have demonstrated. In general, better differentiate what you showed and what your results suggests.

l. 243: How did you measure root activity?

l. 244: What is a vigorous nutrient cycling. Did you measure it?

l. 250-260: I enjoyed the final thought about application, but it makes the conclusion quite long and bring new ideas. This paragraph may be moved to the discussion.

Table A1: I would enjoy a graph or table with the values measured here. N uptake is central in your article (according to the objectives).

Figure 3: What does the different color means? It would be better to rename treatments

with an easy understandable name, instead of D, C1 and C2, which looks more a code for labeling pots.