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Comment on bg-2021-168

Anonymous Referee #2

Referee comment on "Phosphorus stress strongly reduced plant physiological activity, but only temporarily, in a mesocosm experiment with *Zea mays* colonized by arbuscular mycorrhizal fungi" by Melanie S. Verlinden et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-168-RC2>, 2021

This is a well written and interesting paper that reports on the effects of P deficiency on photosynthesis in mesocosm experiment in 2016, and includes an impressive range of measured parameters. It argues that P deficiency has wide range effects on leaf scale photosynthetic parameters, and that mycorrhiza (AMF) can alleviate the low P effects in comparison with fertilized plants, presumably by efficient mobilization of soil P. However, I think there are some issues with the paper, which may require significant changes before publication in BG.

Perhaps the main difficulty I had was due to the fact that this seems to be at least the 5th in a series of papers on the same experiment(s) that cover various aspects of the same story. Notably, the main point of the paper on the AMF compensation for low soil P is already made in the other paper, repeatedly. Further, the other papers seem to contain complementary information that would be hard work to extract to fully understand the current results in the proper context. For example, it seems that the main point is the 'recovery' from 'P stress' in most leaf parameters in the 2nd campaign (on a quick look this is what Fig. 1 generally show: The P stress is essentially gone in C2). But starting with very low rates of photosynthesis (A_{max} J, etc.), one must assume the control were small plants in C2. But there is no info on total leaf area and biomass to account for this. There is no information on the root system to support the conclusion that it's only the AMF that extended the P uptake, and not changes in root/shoot or other forms of expanding root system.

As the authors indicate, P nutrition is linked to ADP/ATP balance, as well as other P-dependent processes, which and can influence the plant functioning. And so, in a detail physiological paper, some of these potential effects could be discussed/mentioned. There are also some textbook type issues but already mentioned in the Discussion so will not repeat, but clearly need to be checked.

The lower leaf P in the C2 in all cases (while N increased) is not clearly consistent with the C2 recovery being an all P recovery, which seems to be the main argument. The link to SLA (a parameter not well defined) is hard to make as SLA also decreased. It seems that P per leaf weight and not area could have helped here. And that the leaf recovery in general was not necessarily (or only) due to P buildup in the leaves

In Fig. 2, panel A can be linked to the Methods, but not panel B, considering the AMF was measured in bags without roots?

Table 1 contains a lot of information but, for example, it is difficult to understand how from C1 to C2 N goes up and P goes down but the N:P decreases?

Finally, another important example of the problematic spread across many papers, is that in some of the other papers (which I just eyed briefly) it seems "ecosystem-scale" GPP (and NPP) was estimated, but there is no discussion on agreement or not with the leaf scale photosynthesis. I think this is a particularly significant point here when what seems to be a purely physiological paper is submitted to a Biogeochemistry journal, but no attempt whatsoever is made to link the P story to biogeochemistry.