Review for Loksin et al. 2023
Direct foliar phosphorus uptake from wildfire ash

This paper is an important contribution to the biogeochemical cycling community. It shows that phosphorus (P) from atmospheric deposition is taken up by plants through foliage, rather than roots. This has implications for how biogeochemical cycles are represented in models. This work has a few issues and sometimes lacks clarity. Overall, these results are very important to the community, and I suggest publication with minor revisions. I would like to review the manuscript again prior to publication.

Major issues:

1. I really appreciate the sequential leach done of the wildfire ash, rather than just soluble and total. However, it is unclear how many samples were run to produce Figure S1. If it is only one, then I recommend at least 2 additional samples are run prior to publication to confirm that this sample is representative of P in fire ash. Please show all fire ash sample results in Fig. S1.
2. Please include a summary of the P in fire-ash results as Fig. 1 in the main manuscript. The atmospheric community will be interested in the results and including this figure in the main manuscript will expand the impact of the work.
3. Similarly, a results and discussion section for fire ash needs to be presented in the main text. Please also discuss how these results compare to previously published P contents and solubilities.
4. The discussion (especially section 4.3) needs clarification and expanding.

Minor issues:

The manuscript contained a few careless errors that a thorough proof-reading would have caught prior to submission. For example, at one point the text refers to a figure that doesn't exist. I recommend thoroughly proofing the text prior to resubmission.

Abstract

Line 17: change particles to ash for clarity.
Line 19: change "that reflect" to "which reflect"
Line 20: This is a little confusing. Please rewrite for clarity – I think there is a way to only use the word "uptake" once in the sentence.
Line 22: add "the" after In a future climate scenario
Line 24: "with fire ash P being the sole nutrient absorbed by the foliage" – This is a very important finding, but it is unclear if it is P only (as opposed to other elements) or if it is fire ash P (as opposed to other aerosol types like dust).
Line 25: I interpret your data as fire-ash P being a particularly efficient and important source of P. If you agree, please add to the last sentence of the abstract to highlight the significance of the results.

Introduction

The intro could benefit from providing some context for the importance of fire as a source of P, particularly to tropical soils that are extremely P-deficient. Even despite tropical soils being depleted in P, they are major carbon sinks, so understanding the biomass response to P deposition to these ecosystems is vital to estimating carbon fluxes accurately. I think a first paragraph around these ideas may highlight the importance of this works' findings and broaden readership.

Line 33: P deficiency is particularly prevalent in tropical soils. Is it really prevalent globally?

Line 34: It is my understanding that P is low in soils because it is leached from soils by precipitation or has been used by plants. The sentence currently reads as "P deficiency is prevalent globally due to its low bioavailability" which doesn't make sense. Please revise for clarity.

Line 38: Savanna's should not be capitalized and should just be "savannas"

Line 37-39: The sentence that starts with "About 65%..." makes it sound like all fire ash particles originate from Africa. Please revise for clarity. I'm not sure what the authors are trying to say.

Line 48: Please do not cite a manuscript under review and take out this paper in the rest of your manuscript. It sounds like it may be accepted soon though. Hope that's the case!

Line 55: There is literature showing that fire ash P is more soluble than dust from Barkley et al., 2019 and references therein). Please update this sentence to reflect this literature.

Lin 61: These papers are ok to cite, but papers from 2014 and 2010 are pretty old in fire science – please add more recent references.

Line 68: Please define eCO2 conditions. I also don't understand why the abbreviation e was chosen. Is there a more intuitive abbreviation that could be used? Does e stand for extreme? Define and explain.

Line 69: Please remove the comma.

Line 74: What is eCO2 and aCO2? This abbreviation should be explained. Is it "actual" and "extreme"?

Last paragraph in introduction (line 73):

Please exclude your hypothesis from this paragraph (sentence beginning on line 76 to end). It's confusing to read this because some of it is opposite of your results. To keep things

clearer, please just say what the question is. For example: "…applied both directly to the foliage and to the roots to assess how plants use P from fire ash deposition"

Line 91: Remove "had"

Line 103: Please add "day" instead of D

Line 108: as should say "ash"

Line 107: Please adjust grammar to say "At this stage, fire ash was applied directly on to the foliage of 12 -P plants…"

Line 111: What is bone-fire burning?

Line 113: Ash is also singular, so please say "Later, the ash was burned again…"

Line 118: move sentences about Tables S1 and S2 to section 2.3 where you discuss the chemical composition methods.

Line 139: This sentence is repeated above. Remove the above one.

Methods

Section 2.3:

It would be helpful to say give a sentence at the beginning of this section describing why each chemical analysis was chosen. For example, say something like "We performed X analysis to quantify total P and a sequential P leach to estimate the different fractions of P." Why was XRD performed? Why was ICP-MS performed? I imagine ICP-MS was done to determine a total P concentration while the sequential leaching was done to determine each P phase. Please state as such.

What does each step of the sequential leach tell us? Which is most soluble?

Line 149: "two separate pulses" is confusing. I think you can just say twice or two times.

Line 154: I understand following P deposition estimates from Gross et al. 2021 30 g/m2, but is this deposition rate reasonable for fires? Discuss why or why not. Even if it's not, I think it's ok because it's still important to be able to compare your results to another study.

Line 158: Please adjust the grammar. "The same amount of ash that was applied to the foliage was applied to the roots."

Line 163: Change to "remaining ash" instead of "ash remains"

Line 166: Should say "Elemental analysis was performed…" instead of "the elements measurement"

Line 167: Change “get rid of the” to “eliminate”

Line 168: Delete “to achieve a clear solution”

Line 179: Why only the P-deficient plants? Please discuss the reasoning.

Line 187: You can say “additional holding capacity analysis was performed at Ben Gurion University”

Section 2.6: Reference for pH measurement available? Why was leaf pH measured? What does it tell us?

Results

3.1:

- What is shoot? Is that the whole plant or the same as the root? Please define and explain why shoot biomass measurements are made for.
- There is no figure 1f or 1e. Please correct so the text refers to the correct figure.
- Figures 1 and 2
    - These figures need to be explained. Please say that they are violin plots. What does the middle dash represent? What do the other dashed lines represent? It’s not standard dev because they are not the same on either side of the center dashed line.
    - Please report the significance and what type of significance test was performed.

3.2:

Please make sure the text refers to the correct figures. There is no figure 2f or e.

3.3:

This paragraph is confusing. Please revise for clarity.

Line 208: Replace “Plant’s nutrient status” to “the nutrient status of plant samples”

Line 208-209: This is poorly worded and confusing, but a major result.

Figure 3:

- Remove interpretation from Figure 3 caption (second the last sentence)
- The legend on the plot does not match the description of the legend in the caption. Please revise.
- Why was P not measured and provided on Fig. 3?

Discussion

Line 278: I think a better and stronger interpretation of your data is that direct foliar application of fire ash is directly beneficial to plants and increases biomass. The word “emphasizing” makes it sound like the results are not novel. Please link the ffact that biomass increase to the plant taking up atmospheric carbon via photosynthesis.

Line 281: Please delete “… confirming out initial hypothesis that fire ash P is more bioavailable to plants” and remove any mention of the hypothesis. The authors could say here “emphasizing the importance of P for plant growth”

Line 281: Please delete “However, despite its projected bioavailability” and replace with something like “because there was no nutritional impact when fire ash was deposited on roots, we conclude the nutritional impact occurred exclusively through foliar uptake”

Line 282: Please delete the sentence that starts with “This discovery.” You do not need to discuss your initial hypothesis. You should instead refer to published literature – how are your results similar or dissimilar to previously published studies? Do your results challenge these studies?

Line 286: Imply should be implies

Section 4.2: Connect to your results again. Do your results agree with other results from the Gross lab?

First sentence in 4.2: You do not need to repeat the same Gross et al. 2021 citation in the same sentence.

I think you need a sentence like “our data showing low pH on plant leaves supports previous assertions that low pH may help facilitate P uptake on plant leaves”

Section 4.3:

Delete discussion of your hypothesis (Line 310). Instead discuss why your results are unexpected based on current literature w/ citations.

Line 308: Should contribution be content? I do not understand this sentence.

This section is generally pretty confusing.

The results presented in Section 3.3 say that the eCO2 conditions reduced the conc of various elements, so the discuss section should discuss why. I feel like the discussion here is missing.

Section 4.4

What is n.d. on line 328?

Line 326: I think the current state thinking is that soluble nutrients like P are more quickly and easily used by the plants after deposition to the soil. Your results are interesting because they contradict that.

Line 328: Delete “in accordance with the common view”

Line 238: Fire also releases N that contributes to N deposition… There is no current N limitation in terrestrial ecosystems because of anthropogenic emissions.

Please discuss how your results inform biogeochemical models. What do the results say about the need for chemical transport model to capture the physics of deposition onto plant leaves? This means that modelers need to have accurate land type model inputs and need to account for surface roughness. Do models currently take deposition onto leaves into account?

SI:

1. Please redefine all abbreviations (except elemental symbols) in SI (e.g., XRF, etc.).
2. Add longer descriptions of each table.
3. How many fire ash samples were analyzed? Figure S1.