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Discussions

Interactive comment on "Effect of iron oxide on nitrification in two agricultural soils with different pH" *by* Xueru Huang et al.

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Dear Reviewers,

We thank you for your most helpful efforts in the evaluation of our manuscript. We have uploaded a revised version of the manuscript that was extensively revised based on the reviewer comments, which we found to be very constructive and useful. Below (Italic font) are our point-by-point responses to the reviewers' comments with references to line numbers in the revised version. Please let us know if further information or modifications are needed. Thank you again for your expert reviewing of our manuscript.

Best wishes,

Xueru Huang (first author)

Printer-friendly version

Discussion paper

Xianjun Jiang (corresponding author)

On behalf of all the authors

Reviewer #1:

The manuscript focuses on effects of iron oxide on nitrification in two agricultural soils with different pH, which is within the scope of Biogeoscience. Nitrification is a key process in the global nitrogen cycle. This paper has an interesting topic and using 15N stable isotope method in this study is appropriate for assessing iron oxide effects on net nitrification, gross mineralization, and microbial immobilization. However, parts of the manuscript are unclear, missing key information, and require further clarifications and better interpretation. This manuscript would also benefit from language editing by a native speaker.

We thank the reviewer#1 for your time. We have carefully considered each comment and thoroughly edited the manuscript to address each of them, with point-by-point explanations of how each comment has been addressed below. We have also substantially edited and strived to improve the English throughout the manuscript. Since considerable edits were made, we have not detailed every action here.

Specific comments:

1. P. 1, L. 9-19: The abstract needs to be more descriptive. Variations in what way?

Re: We have revised the abstract by refining the specific research purpose, descripting to what extent the addition of Fe oxide increased/decreased microbial biomass N in the two soils of different pH, See page 1 lines 11-20 in the revised manuscript.

2. P. 3, L. 64: Please show the date of soil sampling and management history of the land.

Re: We sampled the soils on March 2015. We have added the date of management history of the land by "The low pH soil was sampled from maize plots in a rotation system with sweet potato under conventional cultivation over ten years. In spring maize and autumn sweet potato growing seasons, N fertilizers were conventionally applied as urea at rates of 75 and 225 kg N ha-1, respectively. The high pH soil was sampled from a pear orchard, which was converted from cropland three years ago and never been fertilized or tilled since the conversion." on page 3 lines 75-78 of the revised manuscript.

3. P. 3, L. 70 and Table 1. Statistical data is missing from Table 1. What is "Available Fe" in Table 1? How was it determined? In addition, redox potential (Eh) of soil is important to understanding your data, but it is missing.

Re: Avaibable Fe is the Fe which can be absorbed by soil microorganisms and plants and is extracted by DPTA (e.g. Wang, C., Ji, J., Yang, Z., Chen, L., Browne, P., and Yu, R.: Effects of soil properties on the transfer of cadmium from soil to wheat in the yangtze river delta region, China-a typical industry-agriculture transition area, Biological Trace Element Research,148, 264-274, 2012). We have added the available Fe data in Table 1 and the methodology description of its measurement "Available Fe was extracted using the diethylenetriamine penta-acetic acid (DTPA) method and analyzed by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)."on page 3 lines 88-89 of the revised manuscript.

We agree with the reviewer's comment that the redox potential (Eh) could add more information to our study and contribute to the understanding of the results. In the present study, we used the combination of soil moisture content of 100% WHC and the measurement of concentration of Fe2+, instead of Eh, to provide robust evidence on the redox potential and understand the effect of Fe oxide on soil nitrification.

4. P. 3, L. 77-79: You adjusted the pH of ferrihydrite suspensions to 5.1 and 7.8, respectively, by using KOH. What's the original pH of ferrihydrite suspension? It would be helpful if some basic properties of the Fe oxide were measured, such as specific surface area, zero point of charge, cation exchange capacity and anion exchange capacity. Moreover, X-ray diffraction analysis was performed, but this information was not

presented and discussed in the results and discussion sections.

Re: The original pH of ferrihydrite suspension is 3.7. We revised it in "Preparation of Fe oxide treatments" section. Please see page 4 lines 95-96 in the revised manuscript. We added the figure of X-ray diffraction pattern of ferrihydrite in page 14 lines 401-402.

Thanks for your suggestion for the measurement of the basic properties of the Fe oxide. Since the Fe2+ concentration can be used to understand the Fe reduction and explaining the effect of Fe oxide on soil nitrification, we did not intend to measure the basic properties of the Fe oxide, such as specific surface area, zero point of charge, cation exchange capacity and anion exchange capacity.

5. P. 3, L. 89-91: More details are needed regarding the measurements of total Fe and free Fe oxides. Free Fe oxide data was not presented in the results and discussion sections. Please note "free Fe oxide" in soil cannot be used to represent "available Fe".

Re: "available Fe" but not "free Fe oxides" is the result of the soils chemical property in the table. We have replaced "free Fe oxides" with "available Fe" and described the analysis of available Fe in the Material and Methods section. We have added the information on the measurement of available Fe "Available Fe was extracted using the diethylenetriamine penta-acetic acid (DTPA) method and analyzed by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)." on page 3 lines 88-89 of the revised manuscript.

6. P. 4, L. 92-98: It is not clear as to what experimental design was used in this study.

Re: The experimental design and treatment application as set up as a completely randomized block design, with three replicates per treatment (120 total experimental units comprising 5 soil sampling times). Please see page 4 lines 111-113 in the revised manuscript.

7. P. 4, L. 97: Please justify why soil moisture content was adjusted to 100% WHC?

Re: 100% WHC was chosen to create an oxic-anoxic interface, in which the redox cycle of Fe oxide commonly exists. We have revised justified in “2.4 Soil incubation with 15N substrates” section. Please see page 4 lines 113-114 in the revised manuscript.

8. P. 5, L. 133-136 and Figure 1: LSD test is needed in Figure 1, especially if you want to show a significant decrease in NH4-N.

Re: We agree with the reviewer that it is easier for reader to catch the statistical significant diffference among treatments and days if the statistical results are shown in the figure 1. However, there are treatment and timing two factors, we feel that showing the statistical results between each comparision treatments would complicate the figure and decrease the preference of the figure. Since we only focus on the data changes between day 1 and day 6, we have stated the statistical results in the context where is suitable. See page 6 lines 158-160 in the revised manuscript.

9. General comments on the Results and Discussion sections: In the acidic soil, amendment of Fe oxide resulted in a decrease in microbial biomass, likely due to accumulation of Fe2+ (Figure 4).

Re: Rather than the accumulation of Fe2+, the high solubility of Fe oxide at low pH could impair the assimilation of N by the microbial biomass, and at the meantime, the Fe(III) reduction process could release Fe-bound N and lead to N mineralization and ammonification, thus increasing nitrification potential.

10. P. 6 L. 164-165: The addition of Fe oxide stimulated the net nitrification rate in the low pH soil (pH 5.1) ($F = 63.13$; $P = 0.048$), but suppressed it in the high pH soil (pH 7.8). In the acidic soil, amendment of Fe oxide resulted in a decrease in microbial biomass (Fig. 3), due to toxic effect of Fe2+(Fig. 4). However, the increased gross mineralization and nitrification in the Fe oxide amended soil (Fig. 2) seems to conflict with the decreased microbial biomass (Fig. 4). Similarly, in the high pH soil (7.8), it is difficult to understand that enhanced microbial biomass in the Fe oxide amended soil (Fig. 4) would result in decreased gross mineralization and nitrification. In general, at pH7.8, Fe oxide in soil is quite inertial. The significant decrease in gross mineralization

and nitrification and a significant increase in microbial biomass by amendment of 3% Fe oxide are unexpected.

Re: First, the decrease in microbial biomass N did not attribute to the toxic effect of Fe^{2+}, but the high solubility of Fe oxide at low pH and the reduction between Fe(III) oxide and the released N. Second, the increased inorganic N from the decreased microbial immobilization of N benefits the nitrification, so it is not conflict. As we said, further studies should focus on Fe redox in different pH soils to develop the mechanistic understanding of how Fe oxide changes N mineralization and nitrification through abiotic and biotic-related processes to influence the production of N_2, N_2O and NO_2^-.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2016-170/bg-2016-170-AC1-supplement.pdf

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