SOIL Discuss., 2, C407–C411, 2015
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SOIL Discussions Open Access

Interactive comment on "Biochar's effect on soil nitrous oxide emissions from a maize field with lime-adjusted pH treatment" *by* R. Hüppi et al.

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Received and published: 24 August 2015

The authors present a well written manuscript, giving results from a field study intended to investigate an interesting research question, i.e., whether the sometimes observed reduction of N2O emissions after application of biochar can be attributed solely to a pH effect. For this they measured N2O emissions from control, biochar treated and limed plots.

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Interactive Discussion

Discussion Paper

1 General comments

There are a number of issues that necessitate at least a major revision of the manuscript.

By far the most serious problem is the unfortunate selection of soil type for this study. Reduction of N2O emissions is at most a co-benefit of biochar application. The potential application of biochars to agricultural soils aims at improving soil fertility and soil hydrology (and possibly as well at carbon sequestration). Thus, biochar application to a mollic gleysol is very unusual since a soil with such high carbon content cannot be expected to profit much from it in these regards. Furthermore, and even more importantly, if there are other effects than pH having an impact on N2O they are less likely to occur in a soil with high amounts of native soil carbon. The authors need to justify their choice of soil and discuss in more details the implications on representativeness of their results.

I do not believe that your experiment (on its own) could test the hypothesis that a reduction of N2O emissions is due to a pH effect. If both treatments had reduced N2O emissions (significantly) this wouldn't prove a pH effect.

Your study also only observes relatively short term effects. It is known that liming can cause a short term increase of N2O emissions due to enhanced N mineralization and nitrification. The long term benefits might be better than your results indicate.

The description of the N2O flux measurement method needs also to be more detailed. I'm unfamiliar with the type of analyzer used for measuring N2O concentrations. Please provide a reference and/or briefly explain the measurement principle. You also need to give some numbers illustrating accuracy and precision of that instrument. I would also like to see more details regarding the temperature correction you applied. Also, please describe the chambers in more detail. E.g., did they include a fan or manifold to ensure mixing of the headspace air? Did they include a pressure vent? ... Since apparently

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this is a chamber design were only the lid is closed and opened and the chamber walls are permanently on the plot, have you checked if there was an impact of this on soil humidity inside the chamber (compared to the surrounding soil)?

I'm not convinced that the statistical treatment of the data is correct/optimal. First of all, I don't understand why the data was smoothed as a first step. This shouldn't be necessary and needs more justification. Then, for modeling cumulated fluxes I would suggest to at least try a mixed effects model with random effects corresponding to rows and columns of the plots (although this might be precluded by the low number of plots). Your post-hoc decision to compare only two treatments with a t-test is dubious (read: not allowed). Regarding modeling N2O fluxes in dependence on explanatory variables: Again I don't understand why you work with weekly averages. Also, you write that a GLS has been used. However, a GLS model is only preferable over an ordinary least squares model if you model variance heterogeneity or autocorrelation of residuals. But you do not mention doing that. Also, since you have repeated measures you should definitely use a mixed effects model. Furthermore, you should at least try using WFPS instead of VWC as an explanatory variable. Finally, an assumption of linearity is probably not really appropriate. We know that the relationship between N2O fluxes and soil humidity is usually not linear, but some kind of optimum curve. I suggest using a generalized additive (mixed) model instead of a linear model (see R package mgcv). This model should probably also consider Nmin concentrations.

You should avoid discussing non-significant differences.

It's unfortunate that you didn't measure over a whole year. This does not allow comparing you data to IPCC emission factors, which are based on annual data. However, instead you should calculate and compare N2O emissions per yield, which are actually more important for the GHG balance than emissions per area unit.

The quality of the graphs needs improving. The font size is too small and you use colors even when they are not necessary.

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I would also appreciate if you could provide cumulated N2O fluxes and crop yields for each plot, e.g., as supplementary material. This might be useful for possible meta studies.

2 Some specific comments

796 Line 3ff: Low pH possibly impedes the synthesis of a functional N2O reductase enzyme (Bakken et al. 2012, doi: 10.1098/rstb.2011.0321).

797 Line 12/13: Something is not correct here: C/N = 26.2/0.29 = 90.3. I assume that the N content was actually 2.9 g/kg.

799 Line 25: Where are the results from the CO2 measurements? How were these used in your study?

800 Line 7: I'm not sure whether my bitbucket repo should be used as a reference.

800 Line 7ff: With the relative high number of concentration-time points there might be better decision criteria for (robust) linear vs HMR (e.g., it might be sufficient to rely on Akaike's information criterion with finite sample correction, AICc). Mine were developed for fits to low numbers of points and more research is needed here. Please give information how many fluxes were calculated with which method and some measure of the distribution of flux standard errors. (Note that the HMR package recently corrected the calculation of standard errors and my package includes a function that calculates them correctly.) Anyway, I'm happy that you used a reproducible method.

800 Line 17: I'm somewhat concerned by this. If you have implausible low values it stands to reason that you also have too high values. Only removing the low outliers could result in bias.

803 Line 19: Please always include standard deviations or errors when providing mean

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values.

808 Line 5ff: How does the discussion of P uptake contribute to answering your hypotheses? Omit Fig. 7 or provide it as supplementary material.

Interactive comment on SOIL Discuss., 2, 793, 2015.