Biogeosciences Discuss.,
doi:10.5194/bg-2016-29-RC2, 2016

Biogeosciences
Discussions
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Interactive comment on "Integrated soil fertility management drives the effect of cover crops on GHG emissions in an irrigated field" *by* Guillermo Guardia et al.

Anonymous Referee #1

Received and published: 14 June 2016

Guardia et al. report one year of GHG emissions from an irrigated field in semi-arid Spain, testing the effect of intercropping (barley or vetch) versus winter fallow on different cash crops in its 8th year. The soil is calcareous and has a low organic C content. The management of the cash crop (maize) followed the principals of "Integrated Soil Fertility Management", a concept derived from African intercropping practices that takes into account potentially mineralizable N from mulched catch crops when calculating fertilizer requirements for the cash crop. However, unlike I Africa, the catch crop was mulched with glyphosate. The contribution of different N sources to N2O emissions during the cash crop phase was assessed by 15N labelling of fertilizer N.

The concept of "nutrient management" by catch crops (CC) is well explained and

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the question how different CC-types affect N2O emissions during and after CC-intercropping is valid and timely. The study is technically well described. Notwithstanding, I have a couple of comments and suggestions, which, I hope, will help to improve the manuscript

L. 1-2: The title “Integrated soil fertility management drives the effect of cover crops on GHG emissions in an irrigated field” is hard to understand, if not misleading; it gives the impression that we are dealing with a “mechanistic” which after all is not the case. Even though the 15N experiment clearly showed that barley residues stimulated N2O emissions from AN fertilizer, the mechanisms behind remain elusive. This is a well conducted descriptive study, which should be reflected in the title. I suggest to change the title.

L. 19: Cumulative N2O emissions were indeed low; but who can say whether this was due to ISFM? It was due to the low fertilization rates, perhaps, but this is not specific for ISFM and there was no control following principals other than ISFM.

L. 19. Cumulative N2O emissions lack time dimension

L. 67-69: This section sounds like making hypotheses after the event; if you want to make a point out of the fact that chemically mulched barley can lead to more N2O emissions during the cash crop phase because it fuels denitrification, offer some explanation why and when you would expect denitrification in a silty clay loam under irrigation. State more precisely that a stimulation of N2O emissions from denitrification by high C/N residues should strictly speaking only occur in the presence of ample nitrate, i.e. right after fertilization.

L. 127 ff.: Soil physico-chemical properties. The soil has a very high pH, high bulk density and low organic carbon. Being in its 8th year of intercropping versus winter fallow, should one expect differences in soil properties among these treatments? And could this explain slight differences in WFPS? Please comment or give soil properties per treatment.

L. 159: Why does ISFM maize with barley as intercrop receive 20 kg more N than with traditional winter fallow? Please explain.

L. 162: How was N mineralization from vetch and barley residues estimated?

L. 170: Would you expect that ammonia volatilization at pH 8.2 differs in plots with and without mulched CCs, even after irrigation? Please comment

L. 220: PLOT columns are primarily for separating inert gases, not for "transporting"

L. 223: replace "detector" with "ECD". The FID is not heated.

L. 243: how was the temperature correction carried out? Opaque chambers deployed for 1 hour in a Mediterranean climate may lead to quite some heating of the chamber air. Did you measure temperatures within the chambers?

L. 256: for equation 1, Senbayram et al. (2009) should be cited and not Loick et al. (2016). Equ. 1 requires the knowledge of 15N atm% excess of emitted N2O (L. 257). This is not equal to the atm% of a sample collected after 1 hour chamber deployment minus the atm% at natural abundance (L. 258)! Senbayram applied this equation to a He-flushed closed flow-through system in which subsampled N2O directly relates to emitted N2O. In the present case, the sample is retrieved from a static chamber in which newly produced N2O mixes with abundant "old" N2O. A Keeling plot approach or some mixing calculation should be applied to derive the true 15N excess of soil emitted N2O before calculating the fraction of N2O derived from AN.

L. 271: Did you filter the extract before DOC analysis? Which pore size?

L. 323: . . . most of the time

L. 325: add that the statistically significant difference in soil ammonium between treatments was found on one sampling date only

L. 330: from figure 2e, it is not obvious that mean DOC contents were higher in B than in V, and if so, the difference was marginal. Besides, ordinary ANOVA on averaged time

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series data are not particularly helpful here. Did you use repeated-measure Anova?

L. 344. How can it be that CO2 emissions in plots with intercrops are only insignificantly higher than those in the fallow, of you include plants in your dark chambers and mulch half to 1 tons of dry matter per hectare. Any explanation? Was there a lot of weeds in the fallow? Please give details

L. 388: as outlined above, I believe the absolute numbers for this proportion are wrong. Interestingly, the proportions fluctuated strongly in time but less so across treatments. Did you try to correlate the proportions with any of your ancillary variables (WFPS, temperature, NO3-)?

L. 447: the importance . . . for

L. 447: not clear what you mean by “mineral N harbored in soil micropores”

L. 449: I still don’t understand what your finding of larger fertilizer derived N2O emission in B treatments has to do with ISFM, if ISFM denotes the simple fact that the three treatments received slightly different amounts of fertilizer N. Wouldn’t you expect the same without ISFM? L. 491 ff.: include soil pH in the discussion of possible reasons for the overall low emissions and emission factors

L. 536 and 568: optimal balance between GHG emissions and agronomic efficiency provided by ISFM; I do not think you have evidence enough in your data to claim an optimal balance, as long as there is no control experiment receiving equal amounts of mineral fertilizers.

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