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Biogeosciences
Discussions

Interactive comment on "The soil organic carbon stabilization potential of old and new wheat cultivars: a $^{13}CO_2$ labelling study" *by* Marijn Van de Broek et al.

Anonymous Referee #2

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General comments

The authors address the question whether the aim of modern plant breeding strategies to maximize grain yield may affect soil C dynamics, because these strategies often have the side effect of reduced root biomass and reduced rooting depth. It is a relevant topic, because optimization of C storage in arable lands can contribute to higher soil C storage and better soil functions. The study has the potential to deduce recommendations for a climate-smart agricultural practice.

The authors conducted a 13C pulse-labelling mesocosm experiment with four wheat cultivars in a closed-chamber greenhouse setting. The elaborate experimental design

allows to quantify not only C input, but also soil respiration within a depth profile and is therefore highly suitable to address the question of subsoil C turnover. However, the amount of root biomass in deeper layers was in some cases too low to perform isotopic analyses, which then hampers drawing conclusions on subsoil C input. The thorough experimental set-up comes with the cost of low replication, which may be a reason for the high variability many of the measured parameters exhibited.

Throughout the paper the authors refer to C stabilization, but they actually did not quantify this (rather long-term) process. As in the title, they rather deduce the potential of SOC stabilization from other processes. Therefore, I suggest referring to the (rather short-term) processes that were actually investigated, which were root growth, rhizodeposition and soil C dynamics. Also, they do not present any results on C stabilization itself (which might be challenging given the duration of the experiment) and do not mention this concept in the introduction extensively. I suggest to adapt the terminology to achieve a more precise and coherent wording in a revised version of this manuscript.

Specific comments

Introduction:

The introduction gives a good overview, but could be more concise: Shorten and/or combine paragraphs 2 and 3.

Lines 61f: Please comment on processes that lead to differences in gross and net rhizodeposition. Are there studies on qualitative differences of rhizodepositions between wheat cultivars?

Lines 74f: A bit vague, which practical limitations do you mean?

Lines 90f: Hypothesis: Does the experimental design allow to test C stabilization or rather C input/ C balance? Soil C stabilization mechanisms are not assessed, only inferred from other processes (e.g. root growth, rhizodeposition). As far as I understood your study, you did not differentiate between different soil C forms, e.g. mineral

associated carbon or labile carbon that are a proxy for C stabilization.

Methods:

Well written, good level of detail, mostly easy to follow.

Lines 118f: Why did you choose a cultivar with known high rooting depth? Is this still characteristic for the group of “new” cultivars, or would this be a specific, maybe drought-adapted, cultivar? Since you argue with the two groups of “old” and “new” cultivars later on, I expect your selected cultivars not to be much different from commonly used cultivars.

Line 122: Was this the same topsoil as in the lysimeters?

Lines 127f: Did you measure plant biomass per seedling before transplanting/ labelling? What was the phenological stage of the seedlings? Did it differ between individuals and/ or cultivars?

Line 144: Do you mean CO2 concentration of 58% or 58 atom% 13CO2?

Line 158: Please be more specific, what does “limited amount” mean?

Line 176: 40mg, isn’t this very low? Rather 40g, with 200 ml?

Line 176: Was the chloroform ethanol-free?

Lines 217f: Which input variables do you mean specifically?

Results:

Lines 295ff/ Section 3.1: Is stem and leaf biomass so much lower in Zinal because of much earlier grain filling? Please include data on phenological states for all cultivars or state more clearly if they have been in the same phenological stage (which I assume they have not). You only mention that they all reached flowering stage, but this does not exclude some been even further developed.

Lines 327ff. Do you expect SOC in the initial soil to differ from SOC in the soil in the

lysimeters at the begin of the experiment? If so, how?

Line 345: CO2, not d13CO2 (A value cannot be enriched)

Lines 368ff: What about the d13C of CO2 that was measured in some samples?

Figure 1: Using the same colors for different groups is confusing (e.g. leaves in 1A vs. Zinal in 1B). I don’t find the inset in 1B useful, the statistics could be included in the main figure.

Figure 2, 3: Please use your color coding also for error bars.

Figure 3A: Use an x-axis range that fits the data, starting higher than 0.

Table 1 is redundant, except for root:shoot ratios.

Discussion:

Please do not repeat values, except for comparisons with other studies, where you name their values explicitly. Also, please do not only repeat results.

Line 399: Which differences in root architecture do you have in mind?

Lines 424ff: d13C in roots, variation with depth and cultivar: Why would the d13C signal of plant carbon change throughout the experiment, given that all plants received 13CO2 in regular time periods and equal amounts. Do you expect seedling biomass at the time of transplanting/ before the first labelling to differ and therefore causing these differences? If you started with equal plant biomass and equal amounts of 13C, I would not expect these strong differences in plant d13C.

Lines 431-444: This paragraph is appropriate as part of the introduction, rather than the discussion.

Lines 503ff: Could you test this hypothesis with your data for short-term relationships, independently from cultivar development time, e.g. by looking for relationships between SOC concentration and root biomass or d13C in soil and SOC concentrations?

Lines 531f: Please also mention the share of croplands in total landmass and the share of SOC of croplands in global SOC to give a comprehensive perspective.

Technical corrections

Line 786: Error bar (or bars), not bard

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