SOIL Discuss., referee comment RC1
https://doi.org/10.5194/soil-2021-26-RC1, 2021


# Comment on soil-2021-26

Anonymous Referee #1

Referee comment on "Soil properties after 36 years of N fertilization under continuous corn and corn-soybean management" by Nakian Kim et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-26-RC1, 2021

The manuscript describes the effects of nitrogen fertilization rate and crop rotation (continuous corn cropping and soybean-corn rotation) in a long term experimental station. Effects on soil bulk density and aggregate stability, pH, CEC, organic matter content, inorganic nitrogen, available P and K, and corn grain yield are examined and discussed.

*General comment*

This agronomically shaped paper does not present any unexpected result or breaking-new approach; however, it is of interest for the scientific community, since long-term studies, encompassing 36 years of agronomic history, are uncommon and greatly valuable.

The main issues with this well-written manuscript are probably of methodological nature, thus, they cannot be easily overcome. Nevertheless, the presented data remain of interest, and this overall good work might be published after minor revisions in specific points of the discussion and a few minor technical corrections.

The main methodological issues, involving a lack of important information, or posing some drowbacks in the discussion are listed below.

- Determination of soil organic matter by weight loss on ignition. This method has several disadvantages, linked to the loss of other volatile compounds not directly derived from organic matter and/or incomplete combustion of the organic material. Compared with the use of a CN elemental analyzer, this method does only allow an estimate of the organic carbon, while total nitrogen is not provided and has to be determined with a different analysis.

- Lack of total nitrogen data. Maybe because of the above mentioned choice of the method for SOM determination, total nitrogen data are not reported in the manuscript. This is probably the major bias of this work, focused on the impact of nitrogen supply on soil properties. Thus, the lack of total nitrogen data looks queer and disappointing. The work, instead, presents and widely discusses inorganic nitrogen data (ammonium and nitrate forms). These inorganic forms are, of course, of great importance, being readily available to plants and microrganisms, prone to nitrification/denitrification patterns and, particularly nitrate, highly mobile in soil and prone to water leaching. However, inorganic nitrogen forms account together for 1-2% (or slightly more) of soil total nitrogen; thus, the reader may be curious to learn about the effects of nitrogen supply and legume/corn crop rotation on the remaining 98% of soil nitrogen. Moreover, since several considerations in the discussion are based on the nitrogen content of crop residues, the availability of the trend of the C/N ratio among the reported data would greatly help in sustaining these statements.
- Determination of CEC as sum of exchangeable bases (and acidity?). The method used for the determination of the CEC is unclear. It is described as obtained as the sum of extractable cations, but how were they extracted? The cited handbook chapter (Ross and Ketterings, 1995) cites a number of extractants that can be used for the estimate of the exchangeable basis, but even less clear is the procedure adopted for determining the extractable acidity. The same handbook poses a series of waring concerning the accuracy of this method for CEC estimation, concluding that a direct measure of the CEC would be preferable. I completely agree with this last suggestion. However, since the data have been obtained in this way, I would suggest putting less emphasis on the variation of CEC, both in the Results and in the Discussion sections, since the wide differences underlined in the paper should be proven by a direct method. Since the most interesting result is the increased soil acidity in the continuous corn rotation, the data of exchangeable acidity could be evidenced, and the method used to obtained it has to be better described.

*Specific comments and technical corrections*

Abstract

Page 1, Line 12-13. Please, put less stress on CEC changes, since the method used here provides just an estimate. The differences found here mainly depend on those in the exchangeable acidity, but the method used is even not described, and it is unclear whether the exchangeable acidity was extracted with the same extractant as the exchangeable bases; differently, summing cations extracted with different procedures may be questionable. Instead, you could stress the differences in the exchangeable acidity itself, which are also reflected in the observed pH decrease.

Introduction

Page 3, Line 71. "The lack of quality in soybean residue lies in its biochemistry, which leads to humic acid reductions […]". I would not speak of "a lack of quality" in soybean residues, but just of a different chemical composition. The faster degradation of legume-derived residues compared with corn-derived ones is often attributed to a lower C/N ratio; however, total nitrogen reported by the cited paper (Jagadamma et al., 2007) was higher and the C/N ratio lower for the CC than the SC system (perhaps explainable with the greater amount of N fertilizer supplied to CC compared to SC). Moreover, the cited paper did not report data about the amount and quality of the humified fraction of SOM in both rotation systems and speaking of a decrease in the humified organic fraction is thus speculative.

Page 4, lines 106-107. "However, as the N rate increases, soil pH and CEC will decrease due to nitrification rendering more H+ ions in the soil". Probably nitrification would not be the sole driver of these two hypothesized effects; exchangeable base depletion may also account for soil acidification and CEC decrease would follow SOM degradation. Soil acidification, by itself, would not affect the overall CEC (i.e., the total positive charges that can be hosted on negatively charged soil solid surfaces), rather, the degree of base saturation of the cationic exchange complex. Hence, to properly compare any effect on CEC, a method allowing direct measurement of CEC should be preferred.

Materials and methods.

Page 5, line 143, 146 and 150. "mg kg-1". Check superscript.

Page 5, line 149 (SOM determination); line 151 (CEC determination). See general comment. The availability of total nitrogen data would be warmly welcome.

Results

Page 7, line 191. "NO3-". Please, check subscript and superscript.

Discussion

Page 8, line 226. "NO3- levels increased eight-fold within the top 30 cm, potentially leading to an increase in nitrification within these systems". Since most N was added in form of urea, the increased nitrate concentration found in the surface soil layer in the CC system was not "leading to" an increase in nitrification, but it was a consequence of an increase in nitrification.

Page 8, lines 243-244. “High N rates increased crop yield, and thus, the level of residue returning to the soil in continuous corn management is much higher than the level of residues returned within a corn-soybean rotation”. Wasn't the yield higher in SB compared with CC (Fig. 6)? thus, if the residues are proportional to the yields, CS should have received more residues than CC. Perhaps you mean that, since soybean yields and residues are lower than corn ones, then considering the whole rotation, soybean+corn residues are less than 2 years continuous corn residues. However, residue amounts are not measured. Since this is an important point in your considerations, could you provide any estimate of the different amount of residues reaching the soil in the two systems?

Page 9, lines 250-251. “[…] greater SOC decomposition and priming effect with continuous corn rotation because the microbes rapidly mineralized 250 fresh and relic SOM to obtain N upon receiving N-poor corn residues.” This passage is not fully convincing. N-deficient OM should be more slowly decomposed, since it cannot adequately sustain the growth of the microbial communities. However, since no N fertilizers were added during soybean season, the soil with CC received more N fertilizer and the balance between N-fixation + N addition in SC rotation and N total addition in CC rotation is unknown.

Page 9, lines 255-256. “Soybean residues have lower C:N and decompose faster than corn residues”. Isn't this contradictory with line 250-251? See comment above.

Page 9, lines 267 “Since SOM is a source of CEC, as discussed earlier, more stable soil aggregates may also contribute to greater CEC.” Please, rephrase this sentence; it looks misleading as it is written. CEC is not a direct consequence of soil aggregation. Rather, increased SOM content results both in greater CEC and in increased aggregate stability.

Page 10, lines 304-305. “These nutrients were slightly greater within the deeper layers, closer to the soil parent material, and out of reach from roots of typical row crops” This sentence implies a correct interpretation, but it could be better clarified. It seems not to properly describe the trend of nutrient distribution along the soil profile. The concentration was the highest in the surface layer, it became the lowest in the layers from 15 to 60 cm depth, widely explored my corn root system, and then it slightly (but significantly?) increased again at greater depth, close to the parent material (Tab. 2; Fig. 5b).

Page 11, line 313. “WAS,”. Remove comma.

Conclusions

Page 11, lines 336-337. “We found nearly a two-unit reduction in soil pH and an eight-fold increase in soil nitrates observed from the highest fertilizer rate […]” Compared with?

Page 12, line 341. “the volume of residues returned”. Rather, the mass of residues returned.

Page 12, line 341. “On the other hand, **an** contradicting our original hypothesis” Typo?

Page 12, line 346 and following. “Future work…”. For better understanding the differences among cropping systems, future works considering a deeper physical and chemical characterization of soil organic matter would be suggested. Moreover, the quantification and characterization of both corn and soybean crop residues would be helpful for drawing N (and C) budgets when considering N inputs, outputs and transformation, including studies on GHG emissions.

Figure 6. I would suggest to change the graphic format; at least, please, delete the lines joining the points. Each reported yield measure corresponds to a specific N input. Joining them with a line would suggest a linear increasing trend between the first and the second point, and between the second and the third, which is not necessarily the case (three points are probably not enough to interpolate a trend line). Perhaps a bar chart could be more appropriate. The mean soybean yield could remain marked as a horizontal line in any case.