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Reply on RC2

Sara Niaz et al.

Author comment on "Wetting and drying cycles, organic amendments, and gypsum play a key role in structure formation and stability of sodic Vertisols" by Sara Niaz et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-469-AC2, 2022

Reviewer 2

We appreciate the time and effort the reviewer spent on our paper and for the constructive criticism. We trust that our revisions are satisfactory.

The characterization of microbial activity was only based on microbial respiration since we analysed the changes in dissolved organic carbon using the same soils and same organic amendments under continuous wet conditions in our earlier paper which is now published (Niaz et al 2022). The results showed that dissolved organic carbon is strongly positively correlated with microbial respiration. Likewise, the chemical characterisation of the organic amendments used in this study is published in Niaz et al., 2022 (https://doi.org/10.1016/j.geoderma.2022.116047). We agree with the reviewer that a detailed study of the microbial population can be performed, but this was outside the scope of this paper.

- We have clarified the hypothesis as follows: "We hypothesised that i) organic amendments will increase the microbial respiration and improves the formation of large macroaggregates and MWD, (ii) gypsum will improve aggregate stability due to increases Ca concentration and ionic strength, iii) organic amendments act synergistically with gypsum on aggregation, and iv) repeated WD cycles will increase the process of aggregate formation and stability".
- We have revised the results section as suggested by this and other reviewers.

Line comments

- Organic matter in title has been replaced with organic amendments. The title has been updated as "Wetting and drying cycles, organic amendments and gypsum play a key role in structure formation and stability of sodic Vertisols"
- The full form of PAM has now been incorporated as "In contrast, dispersion was significantly reduced when soils were treated with chicken manure, whilst anionic polyacrylamide only had a transient effect on aggregate stability".
- The four organic amendments were chosen because of two reasons: 1) they were easily available and are being used by farmers, 2) LP is used as green manure and studies have shown it is effective in ameliorating sodic soils, and 3) PAM is used in mining and construction to treat sodic dispersive soils. Furthermore, these amendments were different in terms of their chemical properties (Table 2) and C functional groups (Niaz

et al., 2022) and may give a good contrast between the amendments.

- The 0-10 cm soil layer was chosen because topsoil has the greatest OM content and microbial activity. In any case, Vertisols are relatively uniform in texture and structure throughout the soil profile; using subsoil would not add much information to the study.
- The soil was sieved to 10 mm as we wanted minimise physical disturbance of the natural soil structure. The soil contained no stones or coarse fragments, and the visible plant litter was manually removed.
- The experiment was performed jars with 12 cm diameter and 15 cm height, and the soil was packed to a height of 3-5 cm (depending on the bulkiness of the organic amendments).
- As there were 10 treatments, individual error bars or asterisks would have cluttered the graphs. Therefore, we preferred to insert the Tukey HSD bar in graphs.
- The discussion has been revised as follows "the results of this experiment showed that addition of gypsum (Ca) significantly reduced soil dispersion and increased aggregate stability. This improvement in aggregate stability is because of the increased EC (ionic strength, Fig. S4) and decreased SAR (Fig. S5) after the addition of gypsum. The increased EC likely resulted in the flocculation of soil particles by reducing the diffuse double layer (van Olphen 1977, Ghosh et al., 2010, Bennett et al. 2015). Improved stability was also observed when organic amendments were applied with gypsum especially in G+PAM, G+LP, and G+FLM treated soils, which when applied alone were not able to improve aggregate stability. The PAM had an initial positive effect but led to decreased stability at completion of the second WD cycle. Although, the addition of gypsum increased aggregate stability, it was observed that addition of gypsum did not affect the proportion of large macroaggregates and MWD. However, when organic amendments were added with gypsum an improvement in proportion of large macroaggregates and MWD was observed in G+LP treated soils. This can be explained as Ca-bridging effect through which clay particles are attached to organic matter and polyvalent cations resulting in the formation of macro and micro aggregates (Wuddivira and Camps□Roach 2007)."
- More references highlighted in blue italic colour have been included as "Although the maximum respiration rate was observed during the first WD cycle for LP and G+LP, the proportion of large macroaggregates and MWD increased at the end of fourth WD cycle. However, the proportion of large macroaggregates did not increase much as compared to the first WD cycle, likely because microbial activity was lower (Cosentino et al. 2006; Zhang et al. 2022). One of the possible reasons of increased MWD could be the accumulation of microbial binding agents over time that released continuously from microbial activity due to organic matter decomposition (Rahman et al. 2018).
- The conclusions are revised as "The stability of dispersive sodic Vertisols was improved by the application of organic amendments and gypsum, which was further enhanced by alternate WD cycles. Gypsum reduced soil dispersion but did not affect the proportion of large macroaggregates and MWD. We observed that not all organic amendments were equally beneficial in improving soil aggregation and aggregate stability. LP significantly increased the proportion of large macroaggregates compared to FLM and PAM. In contrast, CM significantly reduced soil dispersion as it had higher calcium content. It was also found that PAM only had a transient effect in controlling dispersion. In the absence of organic amendments, repeated WD cycles reduced the dispersion of sodic soils, but when organic amendments were added (with or without gypsum) soil aggregation and soil stability was improved even more. It is likely that soil microbial activity contributed to the aggregate formation. Implementation of these findings in the field would favour the use of organic amendments with gypsum to improve the physicochemical properties of sodic soils, which is further enhanced by WD cycles. The aim should be initially to prevent soil dispersion which can be achieved by the application of Ca (through application of gypsum) and then to build larger aggregates which can be achieved by the application of organic amendments".