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Comment on soil-2021-136

Frederick Büks (Referee)

Referee comment on "Polyester microplastic fibers affect soil physical properties and erosion as a function of soil type" by Rosolino Ingraffia et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-136-RC2, 2022

In their present work, the authors analyse the alteration of soil structural, soil hydrological and erosion parameters after addition of plastic microfibers. In the first of two experiments, disaggregated soil samples from three locations with different texture (Lt3, Ls2 and Slu, following KA5) were incubated for 6 month to compare the re-formation of total and water-stable aggregates, macroporosity/air capacity and plant available water capacity between treatments with and without microplastic (MP). In a second experiment with similar preparations, the erodibility of soil samples was tested in runoff containers by measuring surface water runoff, drainage and sediment loss. These parameters are known to be influenced by a loss of soil structure and water holding capacity. The combination of both experiments is therfore a good approach to analyse cross-scale effects of MP contamination in soils. Furthermore, MP fibers are a major part of plastic brought into agricultural fields by the application of sewage sludge and have been shown to be adverse to soil structure. The applied concentration of 0.5 % w/w only apperas in highly contaminated areas, but is reasonable. On the other hand, the authors used juvenile MP, which has surface characteristics very different from weathered MP found in the environment. This work can make a significant contribution to our knowledge of the effects of MP on soil structure and landscape erosion. However, from my point of view some improvement is needed. In the following I would like to list a few points which I hope will be helpful for you.

Abstract

Line 20: Please describe in more detail.

Introduction

Line 28: „Improper disposal" sounds a little bit like littering, but MP in remote areas is more from textile fibers or intended application followed by dispersal.

Line 35: Is it „sewage sludge" (without comma) or do you mean „sewage, sludge" in the sense of „waste water and sewage sludge"? There are also other entry pathways like coatings of seeds and fertilizers (very important) as well as irrigation from natural water bodies.

Line 38: Slow degradation – please add a reference.

Line 42: … percolation, cryoturbation, peloturbation.

Line 46: They are related, cancel „more or less strictly".

Line 56: This work is more on changed soil properties than the underlying processes.

Lines 58-59: Is the expected impact assumed to be positive or adverse? Why do you assume that the fragile soils (I think you mean the sandy Alfisol) are suffering the most from MP? I guess, that soils with a high capability of aggregation would be more susceptible. Please deduce your hypothesis.

Material and Methods

In general: The comparison of only the t=6 month data is sufficiant, but t=0 data would be nice.

Line 68: What is „good"?

Line 69: What are „other elements of fertility"?

Line 81: N concentrations change very fastly after sampling due to microbial processes. Is that measurement important for the underlying work?

Table 1: It would be helpful to add a column „texture" using KA5 (Lt3, Ls2, Slu) or SSM.

Line 96: Are the soil macroaggregates entirely disaggregated by the blender? And do you expect significant comminution of fibers during the blending?

Figure 1, a): Why do the 3 soils have 4 colors?

Line 108-109: I think, a „dry-out event" applied to all samples is no problem in this case, and I agree with referee #1 to leave that out.

Line 112-113: Why 8 control replicates and only 4 with MP?

Line 114-141: This section is a bit confusing. Why do you measure so many θ values and use van Genuchten, if you only need the saturated value, field capacity and the permanent wilting point? What is „the value determined at h=-1 m after oven-drying" (after oven-drying, there is pF 6.5)? Why is there an oven-drying in between (which probably disturbs binding factors within the soil aggregates), and can you ensure that the re-packing of samples do not destroy soil structure (and thereby alters the soil hydrological properties)?

Lines 135-136: Macroporosity and air capacity are both defined as the pore space of macropores (>50µm), which are permanently drained due to their low matrix potential. This pore diameter corresponds to pF 1.8. Please explain your choice of pF 1 (0.1 m hydrostatic head) and pF 2 (1 m hydrostatic head).

Line 143: Here, the measurement of soil structure needs a clarification. What is the parameter? (I think, water stable plus water labile aggregates?)

Line 144: Dry-sieving can destroy macroaggregates especially in sandy soils. The subsequent application of wet-sieving to the same samples can lead to artifacts, as the less stable WSA could have been destroyed and the %WSA reduced.

Line 146: If the soil macroaggregates were entirely disaggregated, also the other size classes >250µm give information on newly built macroaggregates.

Line 154: The WSNFA(%) is a tricky parameter. The oberserved increase of WSNFA(%), that comes along with the decrease of NFA(%), can be caused by both, the increase of WSA or a loss of water labile aggregates (WLA) faster than the loss of WSA. The different implications of these two cases should be clearly discussed. Please also reconsider your choice for the WSNFA indicator.

Equations (1), (5) and (7): Why „A" and „P" for weight instead of m?

Equation (6): Please explain the additional information given by the S index.

Line 169: Why „Therefore, …"?

Line 200: It might be helpful to add that 33.4.mm h-1 is a heavy rain event.

Results

Additional Table: What do you think about an additional table containing the trends of all measured soil properties in both experiments?

In general: Is the degree of aggregation after six months within the control samples similar to the degree of aggregation observed in the field? If not, there might be further development of soil structure. Please consider that in MP samples, due to the short term approach, a delayed development of soil structure towards uncontaminated samples cannot be excluded by the experiments. This is important for assessing the environmental risk.

Discussion

In general: The relation between soil texture, soil structure and the influence of MP on aggregation and water holding capacity on the one hand and between the results of the first and second experiment on the other hand are only sparsely discussed by the authors. Starting with a clear-cut hypothesis, the observed alterations should be discussed in terms of their consistency. E.g., the loss of total aggregation in the sandy soil comes along with a loss of macroporosity/air capacity and an increase of water holding capacity, which increases the ratio of percolation to surface runoff and, thus, reduces erosion. What about the more loamy soils? What could be the effect on the landscape scale?

Line 289-290 and 292-293: The Entisol (Ls2) shows alterations very similar to the Vertisol (Lt2). Although both soils differ in their clay content, they are loams, that have a tendency to build stronger soil aggregates. In contrast, the Alfisol (Slu) has a low clay content. Sandy soils do not aggregate very well. Perhaps the explanation of the effects rather benefits from this distinction then from putting Entisol and Alfisol into one class.

Line 306-307: Why should MP, that is occluded within microaggregates, reduce their ability to bond with other microaggregates?

Line 343: Is there a possibility that microplastics prevent soil erosion without having a positive effect on the aggregate structure, e.g. by simply lying around in the way of the runoff?

Conclusion

From my point of view, the conclusion should contain considerations about the effects on the landscape scale (because we have contaminated the whole world with microplastics), long term effects and the role of lower MP concentrations (because common concetrations are some orders of magnitude below the applied 0.5 % w/w, https://soil.copernicus.org/articles/6/649/2020/).

Best regards,

Dr. Frederick Büks (Chair of Soil Science, Technische Universität Berlin)

(If you have further questions, don’t hesitate to ask.)