Publication

Evaluating soil organic carbon stock changes induced by no-tillage based on fixed depth and equivalent soil mass approaches

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 4613956
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Year 2020
Title Evaluating soil organic carbon stock changes induced by no-tillage based on fixed depth and equivalent soil mass approaches
Journal Agriculture, Ecosystems & Environment
Volume 300
Pages / **Article-Number** 106982
Keywords Carbon stock, equivalent soil mass, experimental duration, climatic conditions, no tillage
It is controversial whether no tillage (NT) should be regarded an effective agro-ecosystem management to in-crease soil organic carbon (SOC). Some studies suggest NT leads to a notable accumulation of SOC stock acrossthe whole sampling profile over the long-term, whereas other studies argue that the effect of duration on SOCstock increase is limited. Similar controversy is common with respect to the role of climatic conditions in SOCchanges. In addition, despite the gradual recognition of the importance of equivalent soil mass (ESM) comparedtofixed depth (FD) approach, in terms of SOC stock evaluation, the ESM approach mainly focuses on the directimpact of bulk density but ignores the potential indirect effect on SOC concentration. To further understand theSOC sequestration mechanisms under NT, responses of SOC stock after the adoption of NT were investigatedbased on FD and ESM approaches. The results showed that NT significantly changed the SOC stock distributionin different soil depths according to both FD and ESM, but no significant changes were observed when soilsampling deeper than 50 cm. Notably, the results illustrated that the use of FD overestimated the SOC stock inthe soil surface due to the increased bulk density under NT, but underestimated the SOC stock in 30-70 cm soillayers compared to ESM. Consequently, the overestimate of SOC based on FD may not be as high as previouslyassumed across the sampling depth. Mean annual temperature and mean annual rainfall did not lead to anysignificant changes in SOC stock of the overall soil profile or different layers, indicating the limited impacts ofclimatic conditions on carbon sequestration after the adoption of NT. Long-term NT resulted in a significantaccumulation in SOC stock in the top 5 cm of the surface soil, but SOC stock changes with time in soil layersdeeper than 5 cm was not significant in both FD and ESM approaches. The overall changes in SOC stock as timeincreased were not significant across the whole profile based on FD, but was weakly significant based on ESM.The results illustrate that using the overall SOC stock change of the whole sampling soil profile deeper than 30cm masks the beneficial change in SOC stock in the 0-5 cm soil over long-term adoption of NT. The biasedinterpretation of depth factor is the main reason that fuels the debate over whether long-term NT is beneficial forthe accumulation of SOC stock, and hence must be properly considered. Overall, the data illustrate that the depthfactor is not only important in terms of assessing total SOC stock changes under NT, but also critical whenevaluating the effectiveness of FD and ESM, as well as the impact of experimental duration on SOC increase. Thedepth factor should thus be comprehensively considered in SOC stock assessment and morefield experimentssampling to deeper depth are urgently needed to clarify whether NT is beneficial for SOC sequestration andclimate mitigation.
Publisher Elsevier

ISSN/ISBN 0167-8809
edoc-URL https://edoc.unibas.ch/81205/
Full Text on edoc No;
Digital Object Identifier DOI 10.1016/j.agee.2020.106982
ISI-Number 000540169600010
Document type (ISI) Article