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Clay:organic-carbon and organic carbon as determinants of the soil physical properties: reassessment of the Complexed Organic Carbon concept

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Soil Organic Carbon (SOC) is well known to largely determine the soil physical properties and fertility. Total porosity, structural porosity, aeration, structural stability among others are reported to increase linearly with increasing SOC in most studies. Is there an optimal SOC content as target in soil management, or is there no limit in physical fertility improvement with SOC? Dexter et al. (2008) investigated the relation between clay:SOC ratio and the physical properties of soils from different databases. They observed that the R2 of the relation between SOC and the physical properties were maximized when considering the SOC fraction limited to a clay:SOC ratio of 10. They concluded that this fraction of the SOC was complexed, and that the additional SOC was not influencing the physical properties as strongly as the complexed one.
In this study, we reassessed this approach, on a database of 180 undisturbed soil samples collected from cambiluvisols of the Swiss Plateau, on an area of 2400 km2, and from different soil uses. The physical properties were obtained with Shrinkage Analysis, which involved the parameters used in Dexter et al., 2008. We used the same method, but detected biases in the statistical approach, which was, therefore, adapted. We showed that the relation between the bulk density and SOC was changing with the score of visual evaluation of the structure (VESS) (Ball et al., 2007). Therefore, we also worked only on the "good" structures according to VESS. All shrinkage parameters were linearly correlated to SOC regardless of the clay:SOC ratio, with R2 ranging from 0.45 to 0.8. Contrarily to Dexter et al. (2008), we did not observed an optimum in the R2 of the relation when considering a SOC fraction based on the clay:SOC ratio. R2 was increasing until a Clay:SOC of about 7, where it reached, and kept, its maximum value. The land use factor was not significant.
The major difference with the former study is that we worked on the same soil group, on a large range of texture, with less sandy soils and accounting for structural state.
Our results show that, on this soil group, any SOC increase almost linearly increases the physical properties and, therefore, the physical fertility and the ecological functions of the soil, regardless of the clay:SOC ratio. When considering the whole SOC instead of a fraction, we show that the 10 clay:SOC ratio, however corresponds to a good structure according to VESS and optimal physical values. Therefore, we think reaching a clay:SOC ratio of 10 must be considered as an objective for farmers and advisers.

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