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ABSTRACT BOOK

INNOVATIVE CROPPING AND FARMING SYSTEMS FOR HIGH QUALITY FOOD PRODUCTION SYSTEMS

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Soil Physical and Morphometric Measurements to Investigate Small-Scale Structural Differences Under Strip Tillage Compared to Mulch Till and No-Till

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Abstract: In recent years there has been an increasing application of conservation tillage techniques where the soil is no longer turned, but only loosened or left completely untilled. Dead plant material remains on the soil surface, which provides environmental and economic benefits such as the conservation of water, preventing soil erosion and saving time during seedbed preparation. There is a variety of conservation tillage systems, e.g. mulch till, no-till and strip tillage, which is a special feature. In strip tillage, the seed bed is divided into a seed zone (strip-till within the seed row: STWS) and a soil management zone (strip-till between the seed row: STBS). However, each tillage application affects physical soil properties and processes.

Therefore, STWS, STIS, mulch till (MT) and no till (NT) are investigated using combined classical soil mechanical and computed tomographic (CT) methods on a Chernozem (texture 0-30 cm: silt loam) in November 2015. The parameters dry bulk density (BD) and saturated conductivity (Ks) at 12–18 cm soil depth were determined to classify the initial soil physical condition. Stress-strain tests for the load steps 5, 10, 25, 50, 100, 200, 350 and 550 kPa were performed at 12–18 cm depth. The mechanical precompression stress was determined on the stress-dry bulk density curves. Furthermore, CT images (resolution 60 µm) and morphometric parameters (macropore size, macroporosity, macropore connectivity, anisotropy) of the same soil samples were determined after each load step.

Overall, there were intact soil structures for all tillage treatments where BD values were always lower than the site-specific, root-limiting BD of 1.55 g cm^{-3} and K_s values were higher than 10 cm d−1 as generally recommended in literature. STBS and NT displayed significant higher BD than STWS and MT but only MT showed a significant higher Ks value than NT. The mechanical precompression stress was only significantly higher at STZS (141 kPa) than at STIS (38 kPa). MT (46 kPa) and NT (112 kPa) did not differ significantly from each other or from STWS or STBS in their mechanical precompression stresses. The CT images and the morphometric parameters support the observed mechanically more stable soil structure observed under STBS and NT due to the lack of tillage. On the other hand, STWS and MT have created a loose, porous and connective soil structure. In all variants, the increase in BD, due to increasing stress, led to an increase in anisotropy, while the other morphometric parameters decreased.

It has been shown that ST combines the advantages of NT and deeper soil tillage, as MT and STWS on the one hand and STBS and NT on the other have very similar soil physical and structural properties. In addition, the morphometric parameters can improve our understanding of the functional behavior of the soil using different soil tillage techniques.

Keywords: pre-compression stress, dry bulk density, aggregate density, X-ray, image analysis, soil compaction

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No Till and Organic Farming Improve Soil Properties but Reduce Crop Yield Compared to Conventional Farming in a Swiss Farm Network

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Abstract: Soils are of vital importance for sustainable food production. In order to maintain or improve soil quality, it is necessary to develop strategies for a sustainable use of soil. Alternative cropping practices such as reduced tillage and improved crop rotation are more and more adopted with the aim of decreasing the impact of agriculture on the environment. However, their on-the-ground impact in Swiss farming systems still has to be assessed.

In this study, we quantified the impact of three farming systems (conventional farming, no-till, and organic farming) on plant and soil chemical, biological and physical properties. Our study included 20 fields for each farming system. All selected fields were cultivated with winter wheat the year of sampling. Soil was sampled at four layers, 0-5 cm, 5-20 cm, 20-25 cm, 25-50 cm. The main variables analysed were grain yield, soil nutrient availability, organic carbon stocks, bulk density, aggregation, porosity and soil biology. This was complemented with a comprehensive survey to collect information about cropping practices at field and farm scale, including organic matter inputs, fertilisation, tillage, phytosanitary treatments, and crop rotation.

Our results show a significant influence of cropping practices on plant and soil properties. Wheat yield in no till and organic systems was reduced by 10% and 30% compared to conventional systems. Bulk density was higher in no-till than in ploughed fields in the 5-20 cm layer but similar in the subsoil. A strong stratification with depth of nutrients and soil organic carbon was observed in no-till fields. No-till and organic fields showed larger soil aggregates and higher microbial biomass in the surface layer (0-5 cm). Mycorrhizal colonisation of wheat roots was on average 50% higher in organic fields. However, no differences in carbon stock in the 0-20 cm layer was observed and the ratio organic matter / clay shows a high variability (from poor to good) and was not dependent on the farming system.

Our results show that an improvement of soil properties can be achieved with alternative cropping practices such as no-till and organic farming, but also depends on the other practices adopted by the farmers, such as input of organic amendments, crop rotation diversification, residue management.

Keywords: On farm study, soil quality, cropping practices