Microbial properties in European arable soils with different tillage systems

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Reduced tillage is assumed to be a suitable practice to maintain and promote microbial biomass and microbial activity in the soil. The microbial biomass in particular is considered as a sensitive indicator for detecting soil disturbances. The objective of this study was to quantify the influence of different tillage practices on microbial parameters in the soil. Furthermore, we analyzed the relation of those microbial parameters with site-specific conditions.

To get a deeper insight in that topic, soils from different fields of agricultural farms with different tillage practices in France (12 fields), Romania (15 fields) and Sweden (17 fields) were examined within the “SoilMan project”. The tillage practices were no-tillage (absence of any tillage), minimum tillage (non-inversion tillage for instance by chisel plough or cultivator) and conventional tillage (inversion tillage by ploughing), all of which were carried out for at least five years prior to sampling. Soil samples were taken in spring 2018 from all fields under winter wheat (Triticum aestivum) at three soil depths (0-10 cm, 10-20 cm, 20-30 cm). As microbial parameters we measured microbial biomass carbon and nitrogen contents, ergosterol contents (as proxy for fungi) and basal respiration rates. For site-specific conditions we measured soil organic carbon, total nitrogen and total phosphorus contents, texture, pH and the soil water content.

Results show that microbial biomass carbon and nitrogen were more affected by soil type and soil texture as well as climatic conditions (mean precipitation and temperature) than by tillage practices. For instance, an increased clay content had a positive effect on the microbial biomass and, in addition to the higher average annual temperature, explained the generally low values in France. The lack of inversion tillage primarily led to stratified levels of soil organic carbon, microbial biomass carbon and ergosterol contents, which can be explained by the lack of crop residue incorporation. There were hardly any differences in microbial indicators between the tillage intensities when looking at the whole of the sampled soil profile (0-30 cm). In France, the microbial biomass carbon / soil organic carbon ratio was lower for no-tillage than for conventional tillage, which may indicate, among other things, that the mechanically ground organic matter incorporated into the soil under conventional tillage was better colonized by microorganisms. However, this effect could not be confirmed in the other countries. The metabolic quotient was generally increased at the lowest sampled depth (20-30 cm), irrespective of the cultivation.
We can conclude that the soil tillage intensity influenced the distribution of microbial biomass carbon and soil organic carbon contents more strongly than the total amounts in the sampled soil profile and that the soil texture had a greater impact on microbial soil properties than the agricultural management practice.