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Biological and biochemical soil quality indicators for agricultural management

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Soil quality is defined as the capacity of a soil to perform multiple functions. Agricultural soils can, in principle, sustain a wide range of functions. However, negative pressure exerted by natural and anthropogenic soil threats such as soil erosion, soil organic matter losses and soil compaction have the potential to permanently damage soil quality. Soil chemical, physical and biological parameters can be used as indicators of soil quality. The specific objective of this study is to assess the suitability of novel soil parameters as soil quality indicators. We focus on biological/biochemical parameters, due to the unique role of soil biota in soil functions and to their high sensitivity to disturbances. The novel indicators are assessed in ten European long-term field experiments (LTEs) with different agricultural land use (arable and permanent crops), management regimes and pedo-climatic characteristics. The contrasts in agricultural management are represented by conventional/reduced tillage, organic/mineral fertilization and organic matter addition/no organic matter addition. We measured two different pools of labile organic carbon (dissolved organic carbon (DOC), and permanganate oxidizable carbon (POXC)), and determined DOC quality through its fractionation in hydrophobic and hydrophilic compounds. In addition, total nematode abundance has been assessed with qPCR. These parameters will be related to soil functions which have been measured with a minimum data set of indicators for soil quality (including TOC, macronutrients, and soil respiration). As a preliminary analysis, the Sensitivity Index (SI) for a given LTE was calculated for DOC and POXC according to Bolinder et al., 1999 as the ratio of the soil attribute under modified practices (e.g. reduced tillage) compared to the conventional practices (e.g. conventional tillage). The overall effect of the sustainable management on the indicators has been derived by calculating an average SI for those LTEs which included the sustainable management taken into account. A parametric t-test was used to determine the comprehensive significance of the average SI for a given indicator. Reduced tillage increased DOC and POXC in the 0-10 cm of soil (SI=1.19 and 1.18 respectively) compared to conventional tillage. Organic fertilization increased DOC and POXC in the 0-10 cm compared to mineral fertilization (SI=1.43 and 1.41) and compared to no fertilizer applications (SI=1.27 and 1.17). DOC was slightly more sensitive than POXC, however, the t-test resulted to be significant only for POXC. Preliminary tests revealed a significant correlation between POXC and DOC (Spearman =0.53, $p<0.001$). POXC was more strongly correlated with TOC (=0.8, $p<0.001$), soil respiration (=0.5, $p<0.001$) and total nematode number (=0.25, $p<0.001$), than DOC (=0.37, $p<0.001$; =0.28, $p<0.001$; =0.04, $p=0.5$, respectively). These preliminary results could indicate the better suitability of POXC as soil quality indicator compared to DOC. Further analyses will be implemented to elucidate these relations (including DOC quality parameters and hot water extractable carbon). In the coming months, nematode community composition and abundance of specific groups will be assessed with molecular techniques (sequencing and qPCR). Together, the results will permit to assess the feasibility of the implementation of novel indicators to monitor the effects of agricultural management on soil functions.