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Transformations in soil organic matter and aggregate stability after conversion of Mediterranean forest to agriculture

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Conversion of forest ecosystems into croplands often leads to severe decrease of the soil organic matter (SOM) levels with the concomitant deterioration of soil structure. The present research focuses on the effects of cultivation on the stability of soil macroaggregates, as well as on the total quantity and quality of SOM.

Three representative soils from central Spain (i.e., Petric Calcisol, Cutanic Luvisol and Calcic Vertisol) were sampled. Each site had natural vegetation (NV) dominated either by characteristic Mediterranean forest *(dehesa)* or cereal crops (CC) under conventional tillage. For each site, three spatial replicates of the NV and CC were sampled. Soil aggregate stability was measured by the wet sieving method. The structural stability index was then calculated as the mass of aggregated soil ($>$250 μm) remaining after wet sieving, as a percent of total aggregate weight. The analytical characterization of the SOM was carried out after chemical fractionation for quantifying the different organic pools: free organic matter (FOM), humic acids (HA), fulvic acids (FA) and humin (H). Furthermore, whole soil samples pretreated with 10 % HF solution were analyzed by CP-MAS ^{13}C NMR and the purified HA fraction was characterized by elementary analysis, visible and infrared spectroscopies and Py-GC/MS.

A marked reduction in the proportion of stable aggregates when the natural ecosystem was converted to agriculture was observed. Values of the structural stability index (%) changed over from 96.2 to 38.1, 95.1 to 83.7 and 98.5 to 60.6 for the Calcisol, Luvisol and Vertisol respectively. Comparatively higher contents of SOM were found in the soils under NV (11.69 to 0.93, 3.29 to 2.72 and 9.51 to 0.79 g C·100 g^{-1}soil) even though a quantitative rearrangement of the SOM pools was noticed. In all sites, the relative contribution of the labile C (FOM) to the total SOM content decreased when the forest soils were converted into croplands, whereas the proportion of both HA and FA increased in the cultivated soils. Considering the differences in molecular characteristics of the HAs, cultivation increased aromaticity and humification degree, reflected in the reduction of the H/C atomic ratio and the increase of the E_{465} nm optical density of the HAs. The ^{13}C NMR spectra of the whole soils showed increased signal intensity in the alkyl and *O*-alkyl regions in NV sites compared to agricultural systems. Infrared spectroscopy displayed a less conspicuous pattern in HAs from CC sites. Moreover, the major aromatic pyrolytic products in CC soils were alkylphenols, naphthalenes, benzenes, pyrenes and N-compounds (pyrroles, indoles...), with lower abundance of methoxyphenols regarding NV sites.

Cultivation reduced SOM concentration and macroaggregate stability in the studied soils. The loss of organic C mainly affected labile pools of SOM, which could be partly explained as the organic debris (fungal hyphae, fine roots, polysaccharides) are the main binding agents, so the breakdown of macroaggregates with the tillage exposes the fresh organic materials to microbial degradation. The final consequence is an enrichment on recalcitrant C fractions in the cultivated soils.