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Neutral hydrolysable sugars, OC and N content across soil aggregate size fractions, as an effect of two different crop rotations

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This paper presents the results regarding the effects of two 13 years long crop rotations, on the composition of mineral associated neutral sugars, organic carbon (OC) and N concentration, across different aggregate size fractions. The two cropping sequences were characterized by different levels of N input from plant residues and tillage frequency. We also analysed the changes that occurred in soil organic matter (SOM) chemical composition following the cultivation in the two soils of winter wheat and chickpea on the same soils. The analysis of OC and N content across soil aggregate fractions allowed getting an insight into the role played by SOM chemical composition in the formation of organo-mineral associations, while neutral sugars composition provided information on mineral associated SOM origin and decomposition processes, as pentoses derive mostly from plant tissues and hexoses are prevalently of microbial origin.

Soil samples were collected from two adjacent fields, from the 0-10 cm layer, in November 2011 (T0). For 13 years before the beginning of the experiment, one soil was cultivated mostly with alfalfa (ALF), while a conventional cereal-sunflower-legume rotation (CON) was carried out on the other. Winter wheat and chickpea were sown on the two soils during the following 2 growing seasons and the sampling was repeated after 18 months (T1). A combination of aggregates size and density fractionation was used to isolate OM associated with mineral particles in: macro-aggregates ($>$212 μm), micro-aggregates ($<$200 μm, $>$ 63 μm) and silt and clay size particles ($<$63 μm). For every fraction, OC and N contents were measured by means of elemental analysis, while the content of the following neutral hydrolysable sugar monomers was measured via GC-FID: rhamnose, fucose, ribose, arabinose, xylose, mannose, galactose, glucose.

OC and N contents were higher in ALF as compared to CON for every aggregate fraction, both at T0 and T1. During the 18-months cultivation experiment macro aggregates OC concentration increased in ALF while decreasing in CON. During the same period silt and clay size particles OC concentration decreased in ALF while increasing in CON. N content showed little variations during the 18-months experiment, except for CON silt and clay size particles, where it increased. At T0 CON showed a slightly higher sugars contribution to total OC in the macro aggregates as compared to ALF, while the two soils showed similar carbohydrates contributions in every other fraction. GM/AX varied slightly between the soils.

In conclusion, the crop rotation determined the accumulation of different levels of SOM in the two soils. The 18-months cultivation experiment determined an increase in the tillage intensity in ALF, and the introduction of N rich chickpea residues in CON. Consequently SOM chemical composition responded divergently in the two soils to the change in the soil management. Carbohydrates composition data show that microbial activity by-products accumulated to similar extents across aggregate fractions in the two soils, suggesting that SOM interaction with soil minerals may be influenced by non-microbial related factors, such as organic N content.