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Biochemical approaches to link inputs from perennial energy crops to soil organic carbon

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Soil organic carbon (SOC) is inextricably linked to local land use through the effect of dominant vegetation inputs. The biochemical nature of SOC is generally characteristic of that vegetation type. In the UK, an increasing fraction of former arable land is now under perennial energy crops (PECs), such as Miscanthus and short-rotation coppice (SRC) willow (Salix spp.). The cycling of C in soils under PECs is not fully understood, and the separation of inputs from leaves and roots is even less so. The objective of this research was to improve our understanding of C cycling under different PECs using biogeochemical biomarker and compound-specific stable isotope approaches.

Biomarkers are organic compounds with a defined structure indicative of their origin. Miscanthus is a C4 plant and its biomass inputs to C3 soils can be determined using isotope ratio mass spectrometry, enabling quantification of the abundance and rates of turnover of plant sources of SOC. Furthermore, the relative contribution of above- (leaves) and below-ground (roots) biomass inputs can be assessed using plant organ-specific biomarker compounds from epicuticular waxes (i.e. very long chain n-alkanes) and suberin (ω-hydroxyalkanoic acids), respectively. Characterising the specific biomarker signatures of different PECs and determining their individual dynamics in soils may provide novel insights into bulk SOC dynamics, and provide evidence for which land use types promote increased SOC stocks in agricultural systems.

We present the preliminary results of current experiments exploring C dynamics under different PECs. Leaves and roots were collected from two morphologically-different genotypes of two crops: willow (Salix spp. cvs. Terra Nova and Tora), and Miscanthus (M. $\times$ giganteus (a hybrid) and M. sinensis). Intact 1 m soil cores were taken from beneath the same plants and divided into depth increments. All samples were collected from randomised complete block experiments at Rothamsted Research (UK). Both plant and soil samples were oven-dried and milled prior to total lipid extraction and fractionation to isolate leaf and root biomarkers for analysis using gas chromatography-mass spectrometry.

Preliminary results on leaf material suggest that Salix was dominated by the long-chain C27 n-alkane, Miscanthus contained a dominance of C27, C29 and C31 n-alkanes, and that these patterns dominated in the SOC in the upper part of the soil profile. The n-alkane concentrations in soil declined dramatically below 30 cm, where root-derived SOC is expected to become more abundant. Our future work will characterise the contribution of shoot and root C to bulk SOC down the soil profile under the different PECs to reveal the relationship between SOC stocks and plant inputs, and to quantify the change in SOC stocks under different land use.

Keywords: Carbon compounds, biogeochemistry, soil profile, Salix, Miscanthus