ELS2014 –The Earth Living Skin: Soil, Life and Climate Changes
EGU – SSS Conference
Bari | Italy | 22 – 25 September 2014
ELS2014-99-1

13C abundance shows effective soil C sequestration in Miscanthus and giant reed compared to arable crops under Mediterranean climate

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Many studies on soil organic carbon (SOC) sequestration in perennial biomass crops are available under Atlantic and Continental environments of North-central Europe, while there is insufficient information for Southern Europe. Therefore, we assessed SOC turnover under Mediterranean-temperate climate, after a 9-year old conversion from two annual crop systems, continuous wheat and maize/wheat rotation, to Miscanthus (Miscanthus × giganteus) and giant reed (Arundo donax), respectively. The 13C natural abundance down to 0.60 m was used to evaluate the total amount of SOC in annual vs perennial species, and determine the portion of SOC derived from perennial species. SOC was significantly higher under perennial (average, 91 Mg C ha-1) than annual species (average, 56 Mg C ha-1) with a stronger accumulation in the topsoil (0-0.15 m). This difference was consistent with reduced soil disturbance associated with perennial crop management. After 9 years of Miscanthus plantation, the amount of C4-derived C was 18.7 Mg ha-1, mostly stored at 0-0.15 m, whereas the amount of C3-derived C under giant reed was 34.7 Mg ha-1, more evenly distributed through soil depths. This difference is echoed in the deeper root apparatus evidenced for giant reed in the literature, providing a stronger contribution to SOC in deep layers. Comparing our results with studies available, only for Miscanthus, in North-central Europe, we conclude that Miscanthus and giant reed own a remarkable potential for SOC sequestration also in Mediterranean conditions, exerting effective belowground C sink potential while supporting the growing bio-energy sector with aboveground biomass supply.
Keywords: soil organic carbon, 13C natural abundance, C sequestration, Miscanthus × giganteus, giant reed, Southern Europe