



Soil carbon sequestration is enhanced by tree species richness and functional diversity

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Ecosystem functions and services are strongly related to biodiversity. However, most of the studies on this topic has considered only grassland ecosystems and, in forest, has been focusing on the relationship between aboveground productivity and species diversity. Only very few of them has been designed to specifically investigate the links between tree species richness or functional diversity and soil organic carbon (C) dynamics. In fact, litter decomposition and the turnover of labile soil organic matter (SOM) could be affected by tree species composition, due to differences in litter quantity and quality, in timing of litter inputs and in microclimatic conditions within a stand.

Hence, we investigated the relationships between tree species richness, functional diversity and soil C storage in six mixed deciduous plantations established 19 years ago in North-east of Italy on former arable lands (maize). Plantations differed only in the number of species (3, 4, 6, 7, 8 and 9) whereas climatic conditions, stand age, tree density, soil type, irrigations and fertilizations were the same. In each plantation and in each nearby maize field, soil samples were collected at different depths up to 60 cm according to a replicated experimental design to quantify organic C content, soil bulk density and isotopic signature of soil organic C ($\delta^{13}\text{C}$). Moreover, leaf samples were collected for each tree species to compute functional diversity (i.e. Functional Dispersion Index). We hypothesized that the tree-derived soil C stock increases with tree species richness and functional diversity.

Soil C stocks decreased with depth and most of soil C was stored in the first 15 cm in both maize fields and plantations. As expected, the land use change from cropland to plantation caused an overall significant increase in soil C (+12%; $p=0.05$), mostly at 0-15 cm (+32%; $p<0.001$). Instead, no significant difference in overall soil C stocks among the considered tree species richness levels was detected, even at 0-15 cm ($p>0.05$). However, stable isotopes analysis underlined a clear and significant difference in $\delta^{13}\text{C}$ between soil organic C in maize fields and in plantations at 0-15 cm depth ($p<0.001$), allowing the calculation of proportions of old vs. forest-derived soil C (f_{new}). Thus, a significant increase in f_{new} with both species richness and functional diversity was measured ($p=0.017$ and $p=0.039$, respectively). In fact, tree-derived carbon contributed 48% and 54% to the soil C storage at 0-15 cm in the lowest and highest tree species level, respectively. These results confirmed our initial hypothesis supporting the importance of biodiversity to increase soil C storage in forest ecosystems.