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Free air CO_2 enrichment (FACE) increased litter build up and soil C sequestration in a short-rotation Poplar plantation in central Italy

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The global net terrestrial carbon sink was estimated to range between 0.5 and 0.7 Pg C y^{-1} for the early 1990's. FACE (free atmospheric CO_2 enrichment) studies conducted at the whole-tree and community scale indicate that there is a marked increase of primary production, mainly allocated into below-ground biomass. Enhanced carbon transfer to the root system may result in enhanced root respiration or, otherwise, in an increase of root dry matter and subsequent transfer of carbon to soil C pools. The stability of soil organic matter is controlled by the chemical structure of the organic matter and the existence of protection offered by the soil matrix and minerals

The POPFACE experiment was established early 1999 near Viterbo (42º37'04"N, 11º80'87"E, alt. 150 m), Italy. Nine ha were planted with *Populus euramericana* hardwood cuttings at a spacing of 2×1 m^2. Within this plantation, three FACE and three control plots of 22 m in diameter were randomly assigned. The plots were divided into two parts for N-fertilization treatment. Each half plot was divided into three sectors, where each sector was planted with the following species at a spacing of 1×1 m^2: *P. alba*, *nigra* and *euramericana*.

During the first rotation (1999-2001), total soil C content increased more under ambient CO_2 treatment than under FACE, while under FACE more new C was incorporated than under ambient CO_2. These unexpected and opposite effects may have been caused by a priming effect, where priming effect is defined as the stimulation of SOM decomposition caused by the addition of labile substrates.

During the second rotation (2002-2004), the priming effect appeared to have ceased. The increase of total C in the mineral soil was significantly larger under FACE than under ambient CO_2. N-fertilization and species had no effect on total soil C content. After six years (both rotations), a forest litter layers with three distinctive sub-layers had built up. Total litter C content was significantly higher under FACE than under ambient CO_2.

Chemical fractionation by acid hydrolysis revealed higher labile C contents in the mineral soil under FACE. Respiration measurements confirmed the presence of significantly higher labile C contents under FACE. Modeled respiration data further revealed an increase of the decomposition rate of labile C and an increase of the formation of recalcitrant C (chemically stabilized) under FACE.

Next to chemical structure, the stability of soil organic matter is also controlled by the existence of protection offered by the soil matrix and minerals. The inclusion of organic matter within aggregates reduces its decomposition rate. FACE enhanced the formation of micro-aggregates and increased the physically protected soil C fraction.