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Multiple-years monitoring of Carbon fluxes and allocation pattern in an apple orchard

Damiano Zanotelli (1), Leonardo Montagnani (1,2), Giovanni Manca (3), Francesca Scandellari (1), Fabrizio Mazzetto (1), Wellington Bastos de Melo (4), Paulo Cassol (5), and Massimo Tagliavini (1)

(1) Faculty of Science and Technology, Free University of Bolzano-Bozen, Bolzano, Italy (damiano.zanotelli@unibz.it), (2) Forest Service, Autonomous Province of Bolzano-Bozen, Bolzano, Italy, (3) Air and Climate Unit, Institute for Environmental and Sustainability, Joint Research Centre of European Commission, Ispra, Italy, (4) Embrapa Uva e Vinho, Bento Gonçalves, RS, Brasil, (5) Centro de Ciências Agroveterinárias, Universidade do Estado de Santa Catarina, Lages, SC Brasil

Ecosystem carbon (C) fluxes in an apple orchard (Bolzano, Italy) were monitored by eddy covariance since spring 2009. In 2010, soil respiration and biometric measurements were carried out simultaneously to characterize the whole carbon cycle. Eddy covariance and biometric measurements continued in 2011 and 2012 to assess the inter-annual variability of ecosystem carbon fluxes and the allocation pattern of the newly formed organic C.
Between 2009 and 2012, the annual Net Ecosystem Productivity (NEP) averaged 403±35 (s.e.) g C m-2, Gross Primary Productivity 1346±52 g C m-2 y-1 and Ecosystem Respiration 943±36 g C m-2 of which 62% originated from heterotrophic (Rh) and 38% from autotrophic organisms (Ra, data of 2010). Forty nine percent of net primary production (NPP, 906±69 g C m-2 y-1) was allocated to fruits, 22% to above ground woody organs, 12% to leaves, 10% to fine roots, 2% to belowground woody organs and 6% to the understory (average of three years). The different amount of annual fruit yield markedly affected the yearly values of net biome productivity (NBP), that was slightly positive after four years of measurements (approx. 130 g C m-2).
Pruning wood, fine root turnover, mowed grass, leaf and fruit litter entering the “detritus cycle” accounted for approximately 45% of total NPP, while only a small portion - roughly 5% of total NPP –increased the standing tree biomass. Biologically-related C fluxes in the field were integrated by a LCA study to assess the C footprint of the apple. We have estimated that the average CO_2 stored by the physiological activity of the orchard (NBP approx. equal to 1.2 t CO_2 ha-1 y-1) accounted for approximately 40% of the CO_2 emitted due to orchard management.
Long-term experimental data are needed to assess to which extent conservative management practices might increase the resident time of this newly synthesized C, thereby enhancing the C storing capacity of the orchard, without compromising its high productive potential.