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Organic carbon fluxes in stemflow, throughfall and rainfall in an olive orchard

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The importance of rainfall distribution under the vegetation canopy for nutrient cycling of forest ecosystems has been widely studied (e.g. Kolkai et al., 1999, Bath et al., 2011). It has been demonstrated how throughfall and stemflow reach the soil as chemically-enriched water, by incorporating soluble organic and inorganic particles deriving from plant exudates and from atmospheric depositions (dryfall and wetfall) present on the surfaces of the plant (leaves, bark, fruits). Dissolved (DOC) and particulate (POC) organic carbon inputs from stem- and canopy-derived hydrologic fluxes are small but important components of the natural carbon cycle. DOC has also the capability to form complexes that control the transport and solubility of heavy metals in surface and ground waters, being composed for the most part (75-90%) of fulvic, humic or tanninic compounds, and for the resting part of molecules like carbohydrates, hydrocarbons, waxes, fatty acids, amino and hydroxy acids.

However, very little data is available for agricultural tree crops, especially olive trees. In this sense, the objective of this work is to investigate the concentration and fluxes of organic carbon in rainfall, throughfall, and stemflow in a mature olive orchard located in Cordoba, in Southern Spain and to relate them to rainfall characteristics and tree physiology.

The measurements started in October 2011. Four high density polyethylene bottles with 18-cm-diameter polyethylene funnels for throughfall collection were placed beneath the canopy of each of the three selected olive trees; four more collectors were placed in open spaces in the same orchard for rainfall sampling. Stemflow was collected through PVC spiral tubes wrapped around the trunks and leading into collection bins. The throughflow sampling points were chosen randomly. Total and dissolved organic carbon concentrations in unfiltered (TOC) and filtered (0.45 μm membrane filter, DOC) collected waters were measured using a TOC analyzer with a high temperature combustion system and infrared detection of the evolved CO_2. The difference in concentration between TOC and DOC defined the POC concentration. Leaf area density (LAD) and leaf area index (LAI) of olive trees were calculated using the LAI-2000 plant canopy analyzer (PCA) (Li-Cor).

Stemflow and throughfall resulted both influenced by the characteristics of precipitations (amount, time of the year), canopy volume and leaf characteristics, with stemflow showing, in average, higher DOC and POC concentration values compare to throughfall. Throughfall resulted between 4 and 17 times more concentrated DOC than rainfall, but highlighted a high site-specific variability related to the canopy architecture.

References

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