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Carbon sequestration in a Mediterranean olive orchard managed sustainably over a 20-year period

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Olive is a widespread crop within Mediterranean area and Italy is one of the biggest producer of olives and oil in the world. From an environmental point of view, centered on carbon (C) sequestration, managing olive orchards sustainably is an urgent and actual issue.

This trial was done in a 2-ha olive orchard (*Olea europaea* L., cv. 'Maiatica'; 70-year-old plants, with a distance of 8 × 8 m and NE orientation) located in Ferrandina (Southern Italy, Basilicata region; N 40°29'; E 16°28'). The soil is a sandy loam (Haplic Calcisol - WRB), with a mean bulk density of 1.30 g cm^{-3} and sediment as parental material. The major landform is plain, the slope form is classified as convex-straight and the gradient class as gently sloping (2-5%). Half of the orchard has been managed using sustainable agricultural practices (sustainable management, $_{Sung}$) for 20 years (2000-2020). Trees were drip-irrigated from March to October with urban wastewater. A light pruning was carried out every year during winter. The soil was permanently covered by spontaneous self-seeding weeds, mowed twice a year. Cover crop residues and prunings were shredded and left along the row as mulch.

The other half of the orchard was kept as 'control' plot. It was rainfed and conducted with a locally conventional management (C_{mng}), according to the practices usually adopted by farmers. The C_{mng} was managed by tillage performed 2-3 times per year to control weeds. Intensive pruning was carried out every two years, but pruned residues were removed from the orchard. A mineral fertilization was carried out once per year, during the fruit set and pit hardening phase (early spring).

The average value (n = 5; 0-100 cm soil depth) of baseline soil organic carbon (SOC) stock (related to the C_{mng}) in the 20-year period was 4.79 t SOC ha^{-1}, with an average additional SOC storage potential because of the adoption of the S_{mng} of 0.15 t SOC ha^{-1} yr^{-1}, and a SOC stock after 20 years of S_{mng} of 7.75 t SOC ha^{-1} yr^{-1}.

In the S_{mng} system, soil acted as a significant sink for C, especially due to the supplies of the organic resources internal to the system. The S_{mng} system, made up of mature olive trees, was also able to fix in its aboveground and belowground components, a > 2-times higher total amount of C than the C_{mng}. Spontaneous vegetation was the most important pool, sequestering about 35% of the total fixed C. Also pruning material had a substantial importance in C fixation. Emissions of

CO_2 eq per kg of olives, calculated according to the Life Cycle Assessment (LCA), were 0.08 kg in the S_{mng} system and 0.11 kg in the C_{mng} system. Besides C sequestration, the application of the S_{mng} markedly improved physical, chemical, and biological soil fertility, with benefits on plants and production.

The application of a sustainable soil and plant management makes olive growing a multifunctional rural activity, not only aimed at production, but including many other objectives, such as environmental, landscaping cultural, social and recreational.