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Influence of tree and occasional cropping on soil organic carbon and its fractionation in dehesa system

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Dehesa is a multipurpose agro-silvo-pastoral system used primarily for livestock, and covers around 4 million ha in southern Spain. The dehesa vegetation features oak trees spread in low density without a regular pattern over a pastures/crops understorey. Soil quality can be analysed by concentration of soil organic carbon (SOC) and its distribution in different pools. Previous studies indicate that dehesas have high soil quality and that management practices, spatial patterns, topography, and tree presence affect SOC storage and distribution. Specifically, SOC was reasonably high beneath tree and reduced with depth. Below the depth of 30 cm, the carbon content has not been well defined. The objective of this work was to determine SOC concentration and fractionation in two different dehesas, analysing the effect of depth, management and tree presence. The first area was a pasture dehesa with young holm oaks planted in the early 1990s (70 trees ha-1, 12 m x 12 m). Since 2000, the area has been grazed by sheep (3 sheep ha-1) with three/four non-grazing periods within the year. The second area was a crop dehesa with old holm oaks widely spaced (14 trees in 12 ha paddock), on which a mixture of vetch and oat was cultivated every three years and tilled with a chisel plow. The second area was grazed following every harvest in a similar way as the first area. SOC was determined by Walkley & Black method at different depths (up to 100 cm) beyond and below tree crown. SOC fractionation (unprotected, physically, chemically and biochemically protected) was assessed following Six et al. (2002) method in sections 0-2, 2-5, 20-40, and 40-60 cm. SOC concentration decreased with depth from 1.85% to 0.18%. The decrease was significant in the first 20 cm. SOC was highly variable in 0-2 cm layer, and there was no management, tree, or interaction effect. The presence of holm oaks increased SOC in the soil section between 2-20 cm, although in 10-20 cm section the differences were significant only when trees were old. SOC concentration of unprotected, physically and chemically protected soil fractions decreased with depth. In contrast, the concentration of biochemically protected SOC remained constant in all depths. The unprotected fraction constituted more than 50% of total SOC in the upper soil sections, and decreased with depth. The physically and chemically protected soil fractions constituted between 14-22% of total SOC in all soil sections. Biochemically protected SOC reached 6% in 0-5 cm and increased significantly until more than 20% in the 20-60 cm section. Holm oaks did not have a significant effect on SOC fractionation. Nevertheless, in the 2-5 cm section, pasture dehesa had lower percentage of unprotected SOC and higher percentage of chemically protected SOC than crop dehesa. The results suggest that management could affect SOC up to a depth of 20 cm. While occasional cropping could affect mainly SOC fractionation, planting holm oaks could increase the amount of SOC in the long term.