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Long term impact of organic amendments on forest soil properties under semiarid Mediterranean climatic conditions

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Soil degradation affects more than 52 million ha of land in countries of the European Union (Hueso-González et al., 2016). This problema is particularly serious in Mediterranean areas, where the effects of anthropogenic activities (tillage on slopes, deforestation, and pasture production) add to problems caused by prolonged periods of drought and intense and irregular rainfall (Martínez-Murillo et al., 2016). Depending on the scale of study, soil organic carbón (SOC) dynamics in Mediterranean forests have been found to be particularly sensitive to factors related to seasonal changes in temperature and soil moisture (Casals et al., 2000; Eaton et al., 2008; Hueso-González et al., 2014). During dry periods in theMediterranean area, the lack of water entering the soil matrix reduces organic contributions to the soil (Parras-Alcántara et al., 2016). These processes lead to reduced soil fertility and soil loss (García-Orenes et al., 2010). Restoring the native vegetation is one of the most effective ways to control soil degradation in Mediterranean areas, especially in very degraded areas. In the initial months after afforestation, vegetation cover establishment and soil quality could be better sustained if the soil was amended with an external extra source of organic matter (Hueso-González et al., 2016).

The goal of this study was to test the effect of various organic amendments on select soil properties over a 54-month period. Five amendments were applied in an experimental set of plots: straw mulching (SM), mulch with chipped branches of Aleppo Pine (Pinus halepensis L.; PM), sheep manure compost (SH), hydroabsorbent polymers (HP) and sewage sludge (RU). Plots were afforested following the same spatial pattern, and amendments were mixed with the soil at the rate 10Mg ha-1.

Soil from the afforested plots was sampled in the following: (i) spring 2012 (6 months postafforestation); (ii) spring 2013(18 months postafforestation); (iii) spring 2014 (30 months postafforestation); (iv) spring 2015 (42 months postafforestation) and; (v) spring 2016 (54 months postafforestation). The sampling strategy for each plot involved the collection of four disturbed soil samples taken from the surface (0 to 10-cm depth). The soil properties analyzed were as follows: (i) soil organic carbon (SOC); (ii) pH; (iii) electrical conductivity (EC); (iv) aggregates stability (AS) and; (v) texture (TE).

Regarding to soil aggregate stability, 54 month after the afforestation, the percentage of stable aggregates has increased slightly in all the treatments (HP, RU, PM, SM and SH) in relation to control. Specifically, the differences were recorded in the fraction of macroaggregates ($\geq$ 0.250 mm). The largest increases have been associated with SM, PM and RU treatments. Although the SM, PM and RU treatments helped to maintain the SOC at high levels in the 54 months following application. Conversely, not significant differences relative to the control plots were found for the pH, EC or texture, 54 months following afforestation. To conclude, these results showed an increase in the SOC and the stability of the macroaggregates when soil is amended with sludge, pinus mulch and straw much. This fact has been due to an increase in the number cementing agents due to: (i) the application of pinus, straw and sludge had resulted in the release of carbohydrates to the soil; and thus (ii) it has favored the development of a protective vegetation cover, which has increased the number of roots in the soil and the organic contribution to it.

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