EFFECTS OF MULCHING ON SOIL ORGANIC MATTER IN A BURNT SOIL FROM CENTRAL PORTUGAL

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Introduction

In the last decades, wildfires have become the major environmental disturbance in Mediterranean countries (De la Rosa et al., 2012). One of the principal effects of wildfires is the loss of vegetation and litter cover, which causes a reduction in both rainfall interception and plant transpiration. Consequently, wildfires typically enhance runoff generation as well as soil exposure to the direct impact of raindrops (Shakesby and Doerr, 2006). The most widely accepted measure to effectively reduce post-fire soil erosion is mulching, i.e., the application of a cover of organic compounds on the soil surface (Robichaud et al., 2013). Mulching not only reduces surface water fluxes and their energy but also protects the soil from direct raindrop impact. The effects of mulching on post-fire runoff and soil erosion have been previously studied in various field trials (e.g. Prats et al., 2012). These trials demonstrated that mulching is an effective post-fire soil erosion mitigation treatment. Results from cultivated soils indicated that the addition of organic plant residues to crop soils also helps to improve soil structure, mainly due to an increase in soil porosity, available water content, soil aggregation, and bulk density. Beside this, the detrimental impacts of wildfires on Mediterranean and Atlantic ecosystems is in part caused by qualitative and quantitative transformations of the soils' most functional fraction, i.e. soil organic matter (Faria et al., 2015). Nevertheless, the effects of mulching on soil organic matter (SOM) quality in fire affected soils are still unknown, so that the main goal of the present study is to address this research gap.

Material and methods

The study site was located near the Ermida hamlet in the Sever do Vouga municipality of North-Central Portugal. The site was affected by a wildfire that took place in July 2010 and consumed 295 ha. The presence of gray and white ashes suggested moderate to high severity of fire. The burnt area consisted mainly of eucalyptus (*Eucalyptus globulus* Labill.) plantations, some maritime pine (*Pinus pinaster* Ait.) and a stands of cork oak (*Quercus suber* L.). The climate can be classified as humid mesothermal (Csb in the Köppen classification), with moderately dry but extended summers.

At the end of August 2010, a steep (25º) and short (40 m) slope with southwest orientation was selected for installation of six slope-scale plots (approx. 100 m^2). Three plots were treated with mulch at a rate of 13.6 Mg ha^{-1}, while the other three were left as control plots. The forest residue mulch was composed of chopped eucalyptus bark and twig fibres with an 88% organic matter content. Details of the area of study were described by Prats et al. (2016)

In June 2015, five years after the wildfire, a composite soil sample was taken from each plot at 0-2 cm, 2-5 cm and 5-20 cm depth, using 6 sub-samples at about equal distance from the bottom to the top of the plots

Several OM fractions were isolated from the bulk soils. Free organic matter (FOM) was extracted by rinsing the whole soil in pure water. Humic acids (HAs) were extracted by

successive treatments with 0.1 M NaOH of grinded soils. The extract was acidified to obtain the insoluble HA fraction that was purified by dialysis.
Analysis of FOM, HAs and the bulk soils for total carbon (TOC) content and Carbon stable isotopic analysis ($\delta^{13}C$ IRMS) was carried out in a Thermo-Scientific Flash 2000 HT elemental micro-analyser coupled to a continuous flow Delta V Advantage IRMS. In addition, the samples were characterized by ^{13}C NMR spectroscopy and analytical pyrolysis (Py-GC/MS).

Results

As expected, the TOC content of the mulched soils was significantly higher than that of the untreated soils. As to the impact of mulching on SOM quality, ^{13}C NMR spectra showed higher abundance of Aryl-C and O-alkyl-C compounds in mulched soils when than in control soils. In contrast, mulching had limited effect on the composition of HAs, while the major alterations were found in the FOM fraction.
Pyrochromatograms exhibited a high presence of fire-derived compounds in mulched soils than untreated soils, which suggested that mulching protected the soil against alterations following the fire. The pyrolysis compounds of the FOM fraction of mulched soils mainly consisted of lignin derived compounds, *n*-alkanes and fatty acids, suggesting that they originated from the applied forest logging residues.

Conclusions

The results of this study pointed out that, besides reducing runoff and erosion mulching also contributed to the preservation of the molecular composition of the bulk SOM. It did, however, not seem to have a significant effect on the HA fraction, at least over the first 5 years after mulching. Therefore, the long-terms effects of post-fire mulching on SOM composition would deserve further study.

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