

Burned Soils Regeneration Practices: preliminary studies

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INTRODUCTION

In the Mediterranean Basin, changes in climate and fire regime (increased recurrence and severity) reduce ecosystem services after fires, linked to changes in soil biota, by increasing soil degradation and losses in plant diversity (Moya et al., 2019). High burn severity limited natural vegetation recovery, and reduced biological soil functionality. Soil resources are not renewable at human time scales, and it is fundamental to address future global challenges such as climate change, water scarcity, loss of biodiversity, human health, and food security. Post-fire impacts on soil degradation depends on the fire history, environmental conditions of the area and human management. Burned land, without organic matter, does not produce aggregates and the soil loses its porosity. Thus, rainwater does not penetrate the soil surface and eventually runs down, eroding fields and pastures. Without porosity, soil ventilation is hampered, chemical reactions stop, some of the minerals important for nutrition become toxic, the plant metabolism becomes slow, and vegetation grows poor and weak. Under such conditions, even with high fertilization, crop productivity is poor. Soil dynamics depend not only on physic-chemical properties, but also on micro-fauna and microbiological health because the return of vegetation after a fire is directly impacted by the activity of these organisms. These organisms are not only responsible for the decomposition of organic matter and the formation of humus, but also to close the biogeochemical cycles, allowing the availability of essential nutrients for plants. Some types of post-fire interventions are: salvage logging, site preparation (e.g. ripping), mulching (e.g. straw), seeding, erosion barriers application, and channel treatments. However, some interventions can increase soil degradation: salvage logging, that is carried out in the period immediately after a fire, and the site preparation can lead to soil degradation (e.g. soil compaction, aggregate stability and organic matter loss, reduction of carbon sequestration) and have negative impacts on the vegetation recuperation capacity (Slesak et al., 2015). On the other hand, mulching practices reduce soil degradation. Organic amendments are more appropriate to restore soil nutrients. Overall, post-fire management options can trigger or reduce soil degradation in burned areas. Soils restoration and protection is urgent, but its ecological suitability can only be achieved using methods that improve the natural ecosystem. Mulching has a high capacity to reduce overland flow and soil erosion and increasing some major cation nutrients. However, its impacts on soil organic matter (SOM) quality and quantity or in vegetation recovery is still poorly studied (De la Rosa et al., 2019). Since SOM is the most functional fraction of many soils and, hence, a widely used indicator of soil health and quality, it is important to increase the knowledge of this interaction. The soils restoration with stabilized organic wastes use, as amendment, such as compost, it is not only sustainable, but accelerates the restoration of the burned soils ecosystem, due to the correction of unbalanced physic-chemical and microbiological parameters. Nevertheless, most studies involving fire impacts on soil properties in ecosystems evaluated the effect of short-term rehabilitation techniques on soil erosion and runoff, and some investigated how biotic components are affected when long-term restoration activities were applied. Few studies had integrated a physical and chemical and biological assessment of long-term restoration techniques. This study aims to evaluate the consequences of fires on the soil properties, monitoring their physical and chemical parameters. It will be possible to increase knowledge on soils restoration by mulching and wastes valorization.

METHODOLOGY

The present work studied unburned (UB) and burned (B) areas located in Bodiosa parish, Viseu, Portugal. First, it was done the characterization of the areas, in terms of environmental conditions and physical and chemical properties of the soil. The sampling was made in January 2023 and the characterization was carried out following the standards methods. Then, the 2 areas (UB and B) were used to develop different soil recovery options through mulching, using urban waste (UW) and agro-forestry waste (AFW) composts. The physical and chemical properties of composts were also considered.

RESULTS

During the sampling, the weather conditions measured in the burned area and an unburned area show some differences. In the burned zone, the temperature was 17.7 °C, with a relative humidity of 47.1%. The heat index was recorded at 15.8 °C, the dew point at 5.3 °C, and the wet bulb temperate at 11.5 °C. Atmospheric pressure in

this area was 978.8 mB, at an altitude of 289 m. The wind speed was measured at 1.6 km/h. In contrast, the unburned zone had a lower temperature of 12.7 °C, with a higher relative humidity of 57.4%. The heat index was 13.8 °C, the dew point 6 °C, and the wet bulb temperature 10.1 °C. Atmospheric pressure was 970.1 mB, at a higher altitude of 362 m. The wind speed in this area was 2.8 km/h. These data highlight environmental variations between the two areas, particularly in temperature, humidity, and atmospheric pressure, which may influence the local conditions of the soil. Figure 1 shows the results for physical and chemical parameters used to characterize the unburned and burned soils.

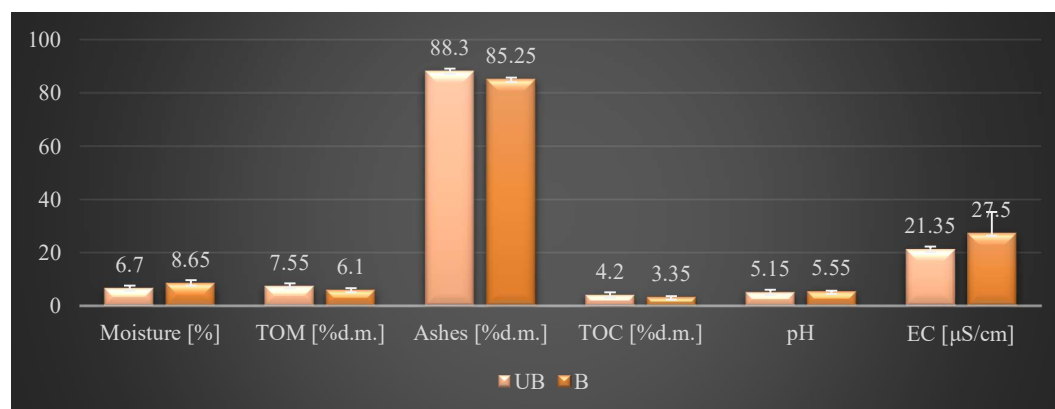


Figure 1 Soils characterization. d.m.- dry mass; TOM – Total Organic matter; TOC – Total Organic carbon; EC - electrical conductivity

Overall, the soils samples exhibited a similar profile, with low moisture content for both samples. They showed low organic matter content, high ash content, an acidic pH, and low values of EC.

For the composts applied, the moisture ranged between 57% and 24.1% for AFW and UW composts respectively, suggesting an adequate moisture level for compost use. The TOM ranged between 53 and 49 %_{d.m.}. The EC for AFW was 410 μS/cm and for UW compost was 4326 μS/cm, which may influence nutrient availability for plants. The pH of the composts was 8, indicating slight alkalinity. The results showed that composts have an important content of essential nutrients. Potassium was found at 0.7 and 1.5 %_{d.m.}, and magnesium presented a content of 0.29 and 1.10%_{d.m.}, for AFW and UW composts, respectively, contributing to plant nutrition. The analysis of heavy metals revealed the presence of Zn at 81.2 mg/kg_{d.m.}, and 483.4 mg/kg_{d.m.}, Cd was detected at 0.46 and 2.2 mg/kg_{d.m.}, Ni at 4.37 and 25.4 mg/kg_{d.m.}, Cu 38.4 and 227.9 mg/kg_{d.m.}, Pb 24.0 and 85.6 mg/kg_{d.m.}, and Cr 27.1 and 42.7 mg/kg_{d.m.}, for AFW and UW composts respectively. According to the Ordinance n°185/2022 (2022), composts may be classified into four classes: I, II, IIA and III, based on their heavy metal content. according with the compost characterization, AFW is a class I, while UW compost is classified as class IIA. Both are within acceptable limits for compost used in agriculture. However, the AFW compost is restricted to arboreal and shrub agricultural crops, namely orchards, olive groves, vineyards and forestry species. The work is still ongoing.

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