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Effects of a simulated drying-rewetting cycle on microbial activity in soils degraded by post-fire erosion

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Large forest fires are expected to occur more frequently in some areas in the Iberian Peninsula with the current climate change predictions. Post-fire soil erosion is an important issue because of its potential large impact on soil carbon stocks and functioning. Addition of mulching to burnt soils has been proved as an effective measure to reduce post-fire erosion. This measure could also increase the stability of microbial activity to drought events, which are also expected to be more frequent in the region.

This study analyzes the response of three measurements of soil microbial activity (dehydrogenase activity, respiration rates and DNA concentration, as an index of microbial biomass) to a drying-rewetting cycle in soils that were burnt during large wildfires and that have been treated with different mitigation measures to prevent post-fire erosion.

Soil samples were collected from two field experiments on post-fire mitigation in Portugal, one in a Maritime Pine plantation over a Humic cambisol and one in a Strawberry tree stand over a Umbric leptosol. These sites were affected by large wildfires in june and october 2017, respectively. At the pine site, three treatments were compared: 1) control plots, where no treatment was applied and post-fire erosion rates were highest; 2) SM plots (Spontaneuos Mulching), in which spontaneous needle cast from the scorched pine crowns occurred (at an average rate of 0.5 kg m^{-2}); 3) HM plots (Human Mulching), in which pine needles (were applied manually at a rate of 0.2 kg m^{-2}. In addition, a nearby unburned Maritime Pine plantation was sampled (Unburnt). At the Strawberry tree site, control plots were compared with plots mulched with wheat straw (WM) at an application rate of 0.2 kg m^{-2}. Sampling involved the organic surface horizon as well as the upper 15 cm of the Ah horizon.

Samples were preincubated during 28 days at 25°C and at 70% of field capacity. Afterwards, they were divided into two sets; one set was subjected to a drought event for 30 days that reduced soil moisture contents to 5-10% of field capacity. Subsequently, the drought replicates were rehydrated until they reached their initial moisture content, which was maintained for 14 days.

Dehydrogenase activity differed significantly between the burnt and unburnt soils, both for the

drying and the re-wetting period. The burnt soils generally were more vulnerable to the drought episode than the unburnt soil. By contrast, dehydrogenase activity did not reveal significant impacts of the different mulching treatments compared to the untreated burnt soils. This was the case for both the organic surface horizon and the subsurface horizon. Respiration rates and DNA concentrations revealed basically the same results.

The three indicators of microbial activity studied here discriminated between burnt and unburnt soils, but they did not suggest any significant improvement in the response to drought by any of the post-fire emergency stabilization measures. Further research on the impacts of such measures on the resistance and resilience of microbial activity to drought should consider other soil quality indicators such as labile organic matter fractions.