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Effectiveness of two contrasting mulching rates to reduce post-fire soil and organic matter losses

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Wildfire-affected soils can reveal strong responses in runoff generation and associated soil (fertility) losses, thereby constituting a major threat to the typically shallow and poor forest soils of the Portuguese mountain areas. Mulching with logging residues from these forests has proven to provide a protective soil cover that is highly effective in reducing post-fire runoff and especially erosion (Prats et al., 2012, 2014, 2016a, 2016b). However, these past experiments have all applied comparatively large amounts of forest residues, in the order of 10 Mg ha-1, so that the relationship between application rate and effectiveness is still poorly known. Such relationship would nonetheless be of crucial importance for the employment of forest residue mulching in practice, as one of the possible emergency stabilization measures to be contemplated in post-fire land management of a recently-burned area. Further research gaps that exist in relation to post-fire forest residue mulching include its effectiveness in reducing soil fertility losses (C, N, P; Ferreira et al., 2016a, 2016b) and in minimizing export of contaminants (especially PAHs and metals; Campos et al., 2016), and its (secondary) impacts on soil biological activity and diversity (Puga et al., 2016) and on forest productivity (including through the addition of organic matter to the soil surface, partially replacing the burned litter layer; Prats et al. 2016b).
In the framework of the EU-project RECARE, the effectiveness of two contrasting mulching rates with forest logging residues has been tested following a wildfire that on August 9th – 10th 2015 consumed some 715 ha of eucalypt plantations in the Semide municipality, central Portugal. Commercially-available logging residues (chopped bark and twigs) from eucalypt plantations were purchased, transported to the study site and applied to six out of nine 16 m2 erosion bounded plots that had been installed in a burned eucalypt plantation using a randomized block design with three blocks. Mulching was applied at a "standard" rate of 8.0 Mg ha-1 as had been done in prior field tests (Prats et al. 2012, 2016a, 2016b) as well as at a reduced rate of 2.6 Mg ha-1. This reduced rate was selected based on the results of laboratory experiments that had been carried out using a 1.00 m $\times$ 0.75 m free drainage soil flume under artificial rainfall and run-on (Abrantes et al., 2017). These results suggested that this reduced rate was somewhat less effective as the "standard" rate.
The results from the first post-fire year in Semide showed that both the "standard" and the reduced mulching rate were not only highly effective in reducing soil losses (with more than 85 %) but also capable of avoiding erosion rates clearly exceeding the tolerable soil loss threshold of 1 Mg ha-1 y-1 proposed by Verheijen et al. (2009). Soil losses amounted, on average, to 8.0 Mg ha-1 y-1 at the untreated plots as opposed to 1.1 and 0.3 Mg ha-1 y-1 at the plots with low and "standard" mulch application rates, respectively. This difference in effectiveness between the two application rates could be related to their difference in protective mulch cover, which corresponded to 48 and 77 % for the low and the "standard" mulching rate, respectively.

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