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Soil properties controlling the effects of fire on water repellency in Terra Rossa

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Soil water repellency (WR) is a common property in fire-affected soils. Burning of litter and soil organic matter in a range of temperatures produces hydrophobic substances. In the soil, WR can produce a reduction in infiltration rates, enhance the runoff and erosion, and can also affect a re-establishment of vegetation because of the reduction of water availability. Most forest soils can develop WR by burning, however it has been observed that some soil types such as "*Terra Rossa*" (mainly Rhodoxeralfs and Haploxeralfs in Soil Taxonomy or Chromic Luvisols in WRB classification) seem to have lower susceptibility to become water repellent as a consequence of fire. With the aim of confirming whether the observed is a common behaviour of terra rossa and to explore the factors controlling the wettability of this soil type after burning, laboratory controlled experiments have been done with samples of terra rossa from 14 different sites. Moreover selected physical, chemical and mineralogical soil analyses have been done in all samples.

Samples of terra rossa were collected from 12 forest sites in the north of the Alicante province (southeast of Spain), and from 2 sites in the "Mt Carmel", in Haifa (northwest of Israel) with similar geological, edaphic and climatic conditions. Samples were taken from the upper 2.5 cm of mineral A horizon. Laboratory burning of samples at

250, 300 and 350ºC was performed without and with the addition of litter of *Pinus halepensis*. WR was measured by the WDPT test, before and after burning. The results confirm that all soils have a very low susceptibility to become water repellent by burning. Without the addition of litter, WR was not detected in any soil sample at any temperature of burning. With the addition of litter, WR was present only in six of the soil samples after some of the heating treatments.

In Mediterranean areas, terra rossa is a very old soil, rich in clay content. Clay content in the 14 studied soils ranges from 15 to 39%, and although all soils had enough soil organic matter (SOM) content to develop WR by heating (ranging from 2.3 to 8.7%), the ratio between SOM and clay contents is considerably lower compared to other types of forest soils of the region in which WR has been found after forest fires (statistically significant difference at $P<0.01$). This could explain in part the lower susceptibility of terra rossa to become water repellent by burning since fine-textured soils are less prone to develop soil WR due to their high specific surface area. From mineralogical analysis of the clay fraction we found that the dominant clay types in the studied terra rossa soils were kaolinite and illite, with the exception of one sample where Ca-montmorillonite content is higher than kaolinite and illite. Ca-Montmorillonite was present in only three of the soils. We compared the soil properties between the 2 groups of terra rossa soils with different behaviour after heating with the addition of litter. The group that in any case did not become water repellent (wettables) was compared with the group that in some cases developed WR (potentially water repellents). We found the following differences: 1- the mean value of the SOM/clay ratio is lower in the wettables, although the difference is not statistically significant; 2- the kaolinite content in the group of wettables is higher ($P<0.05$) than in the potentially water repellents; 3- the three soils containing Ca-montmorillonite are in the group of potentially water repellents. A clear separation between the 2 groups is found when we compare SOM *vs* kaolinite contents, the wettables being the group with higher kaolinite content and/or lower SOM content. The results show moreover that with clay content, the mineralogy of clay is a key factor controlling the appearance of WR in the burned soils. These results are in agreement with those obtained in experiments with clay additions to water repellent soils in order to reduce the WR, and also with some studies which found that kaolinite is one of the most effective clay minerals for this purpose. There are differences in the ability of clay minerals to mask hydrophobic surfaces and to facilitate water penetration. In this sense, some authors have indicated that kaolinite is more effective than Ca-montmorillonite because the last one tends to aggregate, whereas kaolinite remains dispersed, allowing an effective covering of hydrophobic surfaces and facilitating the absorption of water.

From our results we can conclude that, terra rossa soils have a low susceptibility to

become water repellent by burning. The factors that seem to control this behaviour are: 1-the relatively low SOM/clay ratio compared to other types of forest soils of the region, and 2- the high proportion of kaolinite in the clay fraction of terra rossa soils.

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