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What is the role played by organic matter fractions from different sieve-size particles in the development of soil water repellency? A case study using analytical pyrolysis.

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1. INTRODUCTION

It is known that soil water repellency (WR) is induced by organic substances covering the surface of minerals particles and aggregates or present as interstitial substances in the soil matrix. It has also been suggested that the persistence of WR is largely conditioned by specific chemical characteristics of soil organic matter (SOM). Most of these substances are abundant in ecosystems and are released into soils as exudates of roots, organic residues in decomposition, or secretions by fungi and other microorganisms. Soil free lipids correspond to a diverse collection of hydrophobic substances including complex substances as sterols, terpenes, polynuclear hydrocarbons, chlorophylls, fatty acids, waxes, and resins. Some of these organic substances, responsible of soil water repellency may be studied using analytical pyrolisis (de la Rosa et al., 2011; González-Pérez et al., 2011). This research aims to study the relation between soil WR and SOM quantity and quality, assessing the impact of organic fractions and its distribution in soil particles of different size on soil WR from sandy soils.

2. METHODS

Soil samples were collected under selected species growing in sandy soils from the Doñana National Park (SW Spain), cork oak (Quercus suber, QS), eagle fern (Pteridium aquilinum, PA), pine (Pinus pinea, PP) and rockrose (Halimium halimifolium, HH). Soil WR and physical chemical characteristics including SOM content were assessed in fine earth soil samples (< 2mm) and in soil sieve fractions (1-2, 0.25-1, 0.05-0.25 and <0.05 mm). The composition of common hydrophobic substances present in SOM (n-alkane/alkene pairs and n-alkanoic acids) was assessed by analytical pyrolysis. Analytical pyrolysis techniques do not need a pre-treatment, is fast and easily reproducible

3. RESULTS

The severity of soil WR (determined using the WDPT test) may be ordered according to the sequence QS>PA>PP>HH. A positive correlation was observed between WR from each sieve size fraction and SOM content. The most severe WR was detected in QS for all sieve size fractions, followed by the finer fractions form PA, PP and HH samples, which that also shows the highest SOM content, ranging between 20.9% (PP) and 46.9% (QS). Coarser soil fractions (1-2 mm) under PA, PP and HH showed the highest long-chain-even C numbered fatty acids (LCE-FA) in the order PP>PA>HH. No fatty acids were detected neither in sieve fractions 0.25-1, 0.05-0.25 and <0.05 mm from HH samples nor in PA and PP (0.25-1 mm samples). A significant relation was observed between SOM content and severity of soil WR in QS samples and finer fractions of other samples, which is in agreement with previous findings (GOrdillo-Rivero et al., 2013; Jordán et al., 2011). In contrast, 1-2 mm sieve fractions from PP, PA and HH soils showed high severity of soil WR and relatively low SOM contents. This could be explained by a low degree of evolution of organic residues with higher alkane/alkene CPI values and to the presence of a higher diversity of fatty acid structures. These results suggest that soil WR appears as a consequence of lipid compounds in soil.

Some similarities were found in the organic molecular assemblages in PA and PP samples, suggesting a fingerprint of pine residues in PA samples, resulting from ancient pine forests. This finding may be also explained by the existence of exogenous organic inputs associated to fine soil particles from border areas of pine forests.

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