Figure 7. Carbon preferency index (CPI) for each aggregate sieve fraction under Halimium halimifolium (HH), Pteridium aquilinum (PA), Pinus pinea (PP) and Quercus suber (QS).

Results and Discussion

Introduction

Soil water repellency is a property that reduces affinity of water and therefore infiltration capacity having a major impact on hydrological, geomorphological and geoscientific soil processes (Doran et al., 2015). Soil water repellency is widely observed in different climatic conditions, soil types and vegetation covers (Doerr et al., 2000). In the Mediterranean area, evergreen trees such as pines and oaks as well as shrubs are usually associated with the occurrence of soil WR (Lozano et al., 2013). This research attempts to enlighten the relationship between soil water repellency, soil organic matter content and the possible effects of the relative abundance and molecular association of specific hydrophobic substances (β-alkanes/β-alkenes and α-alkanoic acids) present in organic matter.

Methods

Figure 1. Study area.

Study area

Soil samples were collected in the Doñana National Park (SW Spain; Figure 1). The type of climate is Mediterranean, with mean annual rainfall 660 mm (ranging between 2 mm in July and 115 mm in December) and mean monthly temperature 16.9 °C (ranging between 0.5 °C in January and 25.2 °C in June and July). Soils are Arenisols developed from aeolian sandy sediments (Holocene), which form dunes stabilized by vegetation (mainly pine forest and shrubs).

Sample collection and analysis

Four soil samples were collected in a circular area (radius 5 m) under four representative vegetation types—Barren saltbush (QS), Pinus pinea (PP), Pinus elliottii (PA), and Halimium halimifolium (HH) (Figure 2). In the laboratory, soil samples from each vegetation type were homogenized and kept under lab conditions (25 °C and approx. 50% relative humidity) during 1-week period. Dry soil samples were sieved (<2 mm) to discard coarse elements and approx. 50% relative humidity. Dry soil samples were sieved (<2 mm) to discard coarse elements and approx. 50% relative humidity. Soil samples were sieved (<2 mm) to discard coarse elements and approx. 50% relative humidity.

Figure 2. Study area.

Figure 3. Sand fraction from the 1-2 mm aggregate sieve fraction collected under Pinus pinea, which is collecting all organic matter.

In general, a relationship between the concentration of organic matter in soil and water repellency exists (Figure 4). The highest degree of water repellency was observed in PA sample, followed by PP and HH samples, which also has the least amount of organic material and the smallest amount of fatty acids. QS sample shows a relatively high concentration of organic matter (55%) compared to that of HH sample (3%). PA and PP samples also have a lower water repellency content number of fatty acids than QS (Table 2).

Table 2. Chromatograms of aggregate sieve fractions under the studied vegetation types (QS, PA, PP and HH). The water repellency index (WRI) is lower for the HH sample, which is the sample with the highest content of fatty acids.

Figure 6 shows the Total ion chromatogram (TIC) of the 1-2 mm fraction of the soil sample under Pinus pinea, which is collecting all organic substances in the soil sample and chromatograms of each one of various types of organic compounds (in our case, α-alkanols and fatty acids).

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Table 1. Characteristics of organic matter across different aggregated types of vegetation.

Table 2. Characteristics of organic matter under the studied vegetation types (soil-water repellency, WOPF, organic matter content, carbon preference index of long-chained alkanes, (C18/16)), average chain length, KS, and number of long-chained (C10–C12) and even- and odd-number of C fatty acids, LC-IPF.

Table 2 shows the characterization of aggregate sieve fractions under the studied vegetation types (soil-water repellency, WOPF, organic matter content, carbon preference index of long-chained alkanes, (C18/16)), average chain length, KS, and number of long-chained (C10–C12) and even-and odd-number of C fatty acids, LC-IPF.

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Conclusions

The research carried out in this work has focused on two factors: the influence of the amount and type of organic matter on soil water repellency, yielding the following conclusions:

- Soil water repellency varies with different vegetation types. Specifically, the Gaza Strip showed higher repellency than the other areas.
- The intensity of the water repellency was lower in the Gaza Strip, moderate in PA, and high in PP.
- The presence of organic matter in soil increases the persistence of water repellency.
- The presence of long-chain fatty acids and two fractions present in soil increases the persistence of water repellency in the soil.

In conclusion, the study highlights the importance of organic matter in controlling water repellency and the need for further research in this area.

References