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Effect of Plant-derived Hydrophobic Compounds on Soil Water Repellency in Dutch Sandy Soils

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Soil water repellency or hydrophobicity is a common and important soil property, which may diminish plant growth and promotes soil erosion leading to environmentally undesired situations. Hydrophobic organic compounds in the soil are derived from vegetation (leaves, roots, mosses) or microorganisms (fungi, bacteria), and these compounds induce soil water repellency (SWR) and can be called SWR-biomarkers. As common hydrophobic constituents of organic matter, plant lipids are mainly from wax layers of leaves and roots, whereas cutins and suberins as aliphatic biopolyesters occur in leaves and roots, respectively. Their unique compositions in soil can indicate the original vegetation sources.

To investigate the individual or combined effects of the hydrophobic compounds on SWR and their possible associations with each other, we conducted experiments to analyse the organic composition of Dutch coastal dune sandy soils in relation to SWR. DCM/MeOH solvent is used to remove solvent soluble lipids. BF_3-methanol is utilized to depolymerize cutins and suberins from isopropanol/NH_3 extractable organic matter.

Total organic carbon (TOC) has a positive linear relation with SWR only for those soils containing low TOC ($<0.5\%$). The relation between TOC and SWR for higher TOC soils is less clear. For high plant lipids (n-alkanes, n-alcohols, n-fatty acids) extracted from soils under the grasses, the influence on SWR of straight chain lipids depend on their carbon chain lengths. In contrast to long-chain lipids (C24-C32) positively relating to SWR, short-chain lipids (C16-C24) have negative linear relations with SWR. Unexpectedly, SWR increased after removing free lipids by DCM/MeOH. Subsequently, the residual sandy soils were extracted using isopropanol/NH_3. After that, the SWR of soils drastically decreased suggesting the organic fraction extracted by isopropanol/NH_3 may comprise the key hydrophobic compounds causing SWR. Suberins are the abundant components in the isopropanol/NH_3 extracts, which may suggest that suberins, and possibly cutins as well as can be considered as SWR-biomarkers causing the main part of SWR in soils. However, the exact effect of the suberin compositions on SWR has yet to be investigated. From an ecological point of view this is important as cutins are expected to have highest influence in the top soil, which can diminish plant growth, while suberins are expected to have highest abundance in deeper soils. If suberins induce a high hydrophobicity this can capture soil moisture at deeper depths potentially promoting plant growth.