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Factors governing soil water repellency under tillage management: The role of pore structure and hydrophobic substances

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Abstract

Soil water repellency (SWR) has significant effects on soil degradation by changing some soil processes (e.g., carbon sequestration and soil erosion). Understanding the influence factors of SWR under conservation agriculture are playing a vital role in the sustainable development for improving soil quality. However, how soil pore structure influence on SWR remains unclear. We aim to assess the impact of hydrophobic substances and pore structure on SWR. Here we conducted two long-term experimental fields with three treatments: conventional tillage (CT), reduced tillage (RT), and no-tillage (NT). X-ray tomography and the sorptivity method were used to measure soil pore structure and SWR, respectively. We found that soil organic carbon (SOC) and microbial biomass carbon (MBC) were higher in RT and NT treatments than in CT. MBC had significant influences on soil water sorptivity (S_w) and water repellency index (RI; $p < 0.001$), whereas SOC had no influence on S_w ($p > 0.05$). MBC also showed a closer relationship with SWR than SOC in redundancy analysis. The RT and NT increased the porosity of 55–165 μm that had a positive relationship with ethanol sorptivity and RI ($p < 0.05$). Ethanol sorptivity increased with an increase in soil pore porosity and connectivity under RT and NT treatments. However, increasing the pore surface area could decrease S_w due to enhance contact area between hydrophobic substances and soil water. Overall, the RT and NT treatments increased the water repellency index, which was a result of the interactions between pore structure and hydrophobic substances.

KEYWORDS
conservation tillage, soil carbon, soil pore structure, soil water repellency, X-ray computed tomography

1 | INTRODUCTION

Soil water repellency (SWR) is a common phenomenon in coarse- to fine-textured soils across all climatic zones (Daniel, Uddin, Harper, & Henry, 2019). SWR can limit the soil water absorption rate and capacity (Dekker & Jungerius, 2000; Li, Yao, Tang, Chau, & Feng, 2019), resulting in strong influences on the soil degradation and crop growth (González-Peñaloza et al., 2012; Martínez-garcía, Korthals, Brussaard, Bracht, & De, 2018). A lot of research has already been conducted to reveal the impact of SWR on the soil ecosystem

