Fungal and plant influences upon soil wetting

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Plants and fungi produce hydrophobic compounds that can influence soil wetting. Diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy is proposed to give a rapid non-destructive measure of organic material containing aliphatic C-H groups, thought to be hydrophobic components of organic matter (Ma'shum et al., 1988; Capriel et al., 1995).

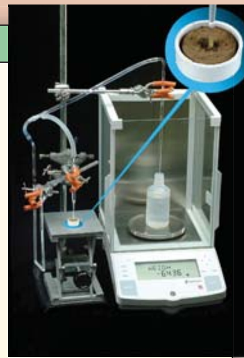
Converting DRIFT peak area to mg of C-H has not been previously possible due to the complex structure of soil organic material (Capriel et al., 1995).

Aims

Assess DRIFT as a way of quantifying hydrophobic chemical compounds in soil.

Compare DRIFT with measures of water sorptivity and repellency.

Methods



Tests were carried out on pure Kaolinite clay and an arable soil. Organic matter was removed from the arable soil by muffle furnacing

Three biological exudates were added to soils:

- Scleroglucan (trade name: Actigum): a fungal exudate shown to affect clay/water interactions and influence particle binding (Chenu, 1993).
- Polygalactouronic Acid (PGA): a compound present in root mucliages, which directly influences soil water absorption (Czarnes et al., 2000).
- Lecithin: a surfactant chemically similar to phospholipid surfactants identified in plant root mucilages (Read et al., 2003).

Exudates were added to both Kaolinite and furnaced soil at concentrations of 0, 0.01, 0.1, 0.5, 1, 2 & 3 mg g^{-1}.

Aliphatic C-H groups were quantified through IR spectroscopy, with DRIFT spectroscopy detecting C-H stretching absorbance between 3000-2800 cm^{-1} (Figure 1). Water repellency and sorptivity was measured using a miniature infiltrometer (Hallett and Young, 1999).

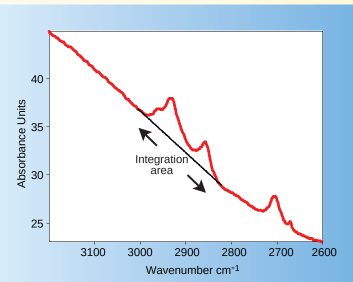


Figure 1. Aliphatic C-H peaks, integration area.

Results

Kaolinite and furnaced arable soils showed positive correlations between peak area and chemical concentration for all exudates (r^2=0.86-0.99) (Figure 2).

Kaolinite treatments showed a significant decrease in water sorptivity with increasing chemical concentration (*P<0.01*), as did furnaced soil samples (*P<0.001*).

No significant differences in water repellency were detected in kaolinite between exudates at the largest concentration, 3 mg g^{-1}. Exudates significantly increased water repellency in furnaced soil.

Correlations between sorptivity and repellency, and DRIFT peak area showed a poor correlation between peak area and soil water measurements (Figure 3)

Greater water repellency (with lower levels of water sorptivity) was detected in chemically amended furnaced soil samples in contrast to kaolinite samples.

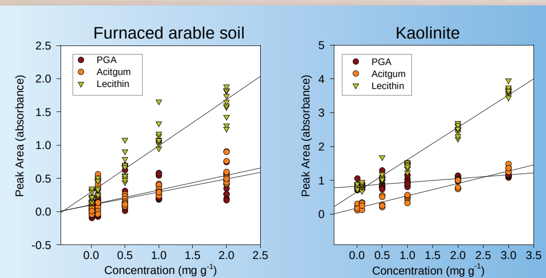


Figure 2. Chemical concentration versus DRIFT peak area.

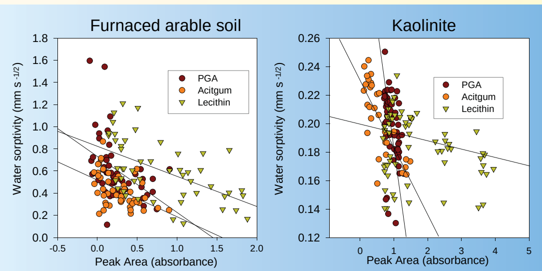


Figure 3. DRIFT peak area versus water sorptivity

Conclusions

DRIFT is an accurate means of estimating the concentration of aliphatic C-H groups within a soil.

Differing particle properties between soils may affect the orientation of molecules and as a consequence the resulting repellency.

DRIFT quantifies the presence of C-H compounds well; however, we found that it could not be used as a surrogate measure of repellency, as particle properties and organic material orientation were of equal or greater importance.

Acknowledgements

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