Sources and characteristics of water repellency in machair soil

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Introduction

- Water repellency arises from hydrophobic organic compounds present in the soil as coatings on mineral surfaces or as particles
- Water repellency adversely affects water infiltration and can lead to poor plant growth and soil erosion
- Crofting, traditionally a low-intensity agricultural system, is practised on calcareous sandy soils with low organic C called 'machair', in NW Scotland and Ireland (Fig. 1). Cultivation includes shallow ploughing, using kelp (seaweed) as a fertilizer and soil conditioner (Fig. 2).
- The machair soil exhibits water repellency during dry periods in summer

➢ Objectives: To characterize the water repellency in machair soil and evaluate if agricultural practices can alter the severity of the repellency.

Figure 1 Machair fields

Figure 2 Kelp on beach

Materials and methods

Soil from a first year bere barley field by Drimsdale, South Uist, was exposed to different treatments

- Mechanical disturbance (soil mixing)
- Kelp
- Plant material
- Artificial NPK fertilizer

The effects of treatment upon water repellency was assessed by

- Water drop penetration time (WDPT)
- Attenuated Total Reflectance Fourier Transmission Infrared Spectroscopy (ATR-FTIR).

Results

- Mechanical disturbance induced water repellency, and the severity of the repellency increased with duration of the disturbance (Fig. 3)
- Amendment with kelp and plant materials initially decreased water repellency relative to the control. After 14 days plants shoots and roots strongly increased repellency, whereas the water repellency of the kelp treatment remained unchanged (Fig. 4)

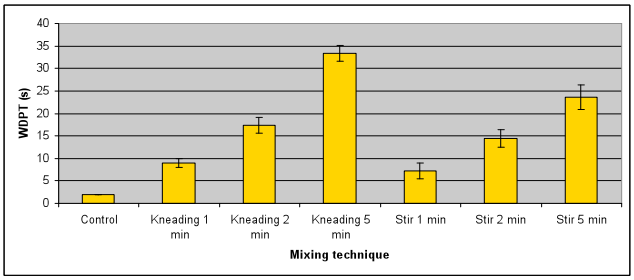

Figure 3 The effect of different mixing techniques and duration of mixing upon WDPT

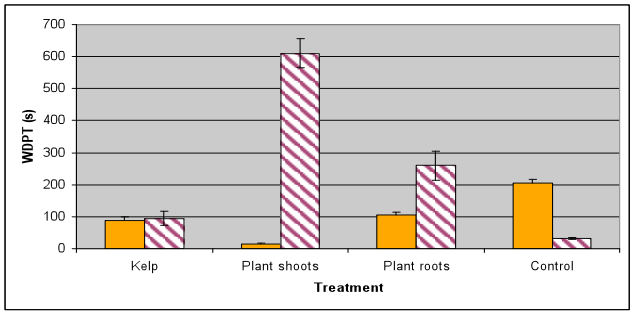

Figure 4 The effect of organic amendments upon WDPT (s) initially (yellow bars) and after 14 days incubation (striped bars)

Results (cont.)

- NPK fertilizer decreased water repellency relative to the control, both initially and after 14 days incubation (data not shown)
- Values for WDPT of the controls between experiments are not consistent (Fig. 3 and 4)
- ATR-FTIR analysis gave good separation of different organic samples and soil (Fig. 5), but the absorbance of hydrophobic compounds was not correlated with initial effect on WDPT (Fig. 4).

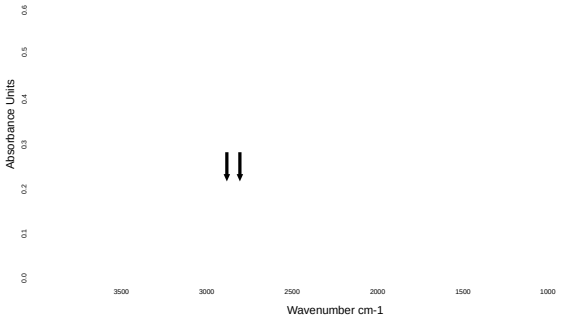

Figure 5 ATR-FTIR spectra (single replicates) of machair soil (red), machair soil sieved to <0.125mm (pink), kelp (green), mixed roots from machair soil sample (brown) and bere barley shoots (blue). Arrows indicate peaks for hydrophobic compounds.

Discussion

- As disturbance increases water repellency, possibly by breaking up aggregates and exposing new hydrophobic organic matter, ploughing might have a similar effect in the short term
- Heterogeneity in water repellency at the field scale and within-sample, and the lack of correlation between hydrophobic organic compounds and repellency makes predictions and interpretations difficult
- Dynamics in organic matter degradation strongly affects water repellency, crop shoots in particular
- A good understanding of these dynamics is necessary to optimize agricultural management and minimize adverse effects on plant water uptake and wind erosion. Minimal ploughing and removal of crop shoots from the field could help decrease water repellency, but may create other problems such as decreased crop performance and low soil organic carbon pool.

Acknowledgements
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