ANALYSING SOIL STRUCTURE UNDER DIFFERENT TILLAGE SYSTEMS USING X-RAY MICROTOMOGRAPHY AND PF CURVES

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Assessing soil structure is primordial when comparing tillage systems. Whilst most conventional techniques characterize global parameters, X-ray microtomography allows a characterization of the poral space at a µm-scale. These results, combined with data from pF curves, can form a solid basis in order to quantify soil physical fertility.

Soil samples were taken from the organic topsoil on two Belgian experimental sites implementing both conventional tillage (CT, ploughing) and simplified tillage (ST, superficial works), without straw restitution: Gentinnes, Brabant Wallon (March 2010), and Gembloux, Namur (November 2010). On the Gentinnes site (Aba(b)1), CT and ST have been implemented since October 2005, with a beet/winter wheat rotation. On the Gembloux site (Aba(b)), CT and ST have been implemented since September 2008, with a winter wheat cultivation since end 2009. Tomography (10 samples for Gentinnes, 8 for Gembloux) and pF curves (10 samples for Gentinnes, 14 for Gembloux) were used for analysis. Pressure pans were used in order to obtain the pF curves on 100 cm³ undisturbed samples. Soil cores (3 cm diameter, 5 cm height) were scanned using a Skyscan-1172 µ-CT device. The conical beam, operating at 100 kV, produced images having a 17µm pixel size, using a 16-bit 1048×2000 pixels camera equipped with an aluminium filter. The raw images were then treated under Matlab® for binarization, using a thresholding loop to fit the measured and the calculated porosity of each sample (Beckers et al, 2011). The 2D binary images were then analyzed under Matlab® and Skyscan™ CT-analyzer.

On the site of Gentinnes, pF analysis showed a greater available water content (between pF 4.2 and 2.5) for ST, and a greater efficient porosity (between saturation and pF 2.5) for CT. The differences in available water content, although not significant, were confirmed by site observation. Tomography analysis yielded the following: under ST, the pores are smaller and the anisotropy less developed. As for the poral connectivity, it was found greater in CT.
On the site of Gembloux, however, no significant differences were found between the tillage systems concerning the pF curves. Tomography analysis showed smaller pores for simplified tillage, but the differences deduced by the tomographic analysis of the Gentinnes samples concerning connectivity and anisotropy were not found in this case.

To conclude, from the results, the soil structure is found to differ between CT and ST. The pores tend to be smaller and less oriented in ST, whilst in CT pores are more connected. Soils undergoing a CT show a greater efficient porosity, whilst soils under ST display a greater available water content. However, these differences were mostly spotted on the Gentinnes site: in Gembloux, the differences between the samples were less marked. This could be due to the fact that the soil did not have time to differentiate yet (less than 3 years of tillage differentiation). More sampling is needed in any case before inferring general conclusions from these observations. A further analysis of the soil images, especially concerning pore orientation, will be done in order to fully exploit the tomography results.

Reference:
Beckers,E et al., 2011, *Impact of thresholding techniques on X-ray soil microtomogram analyses*, Geophysical Research Abstracts, Vol 13, EGU2011.