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Comparison of agricultural soils' structure depending on tillage system using X-ray microtomography

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This study aims at characterizing agricultural soils' structure depending on the tillage system: conventional tillage or conservational tillage. Tillage reduction is an increasing practice, but the micro-structural effects on soils and on their hydrodynamic parameters are still not well described. Recent research shows non-converging results. Our point is to highlight fundamental differences in structure through characterization of soils porosity's parameters using X-ray microtomography measurements coupled to image analysis. This attempt is in line with a more integrated experiment of which the aim is to quantify the effects of tillage intensity on lateral flow production, and finally on global water balance. Parameters' measurements consist in a combined approach, based on two different space-time scales of exploration: fundamental scale, with soil sampling campaign for microtomography analysis, and field scale, with continuous flow measurements (plots' dimensions: 18*28 m). For their part, parameters for water balance determination (precipitation, evapotranspiration...) are monitored on the field. All of these measurements have the main objective of hydrological modeling enhancement by taking into account a better lateral flow description. Discussion in this paper will focus on the first results obtained by X-ray microtomography measurements.

Our experiment takes place in Gentinnes (Walloon Brabant, Belgium), on a field organized in a split-plot scheme. Since 2004, plots have been cultivated in conventional tillage or in reduced tillage. The latter consists in sowing after stubble ploughing of about 10cm. The crop rotation is sugar beet followed by winter wheat. The soil is mainly composed of silt loam. Soils samples, with a 3 cm diameter and a 5 cm height, were removed from the upper layer (Ap horizon) for both management practices. Samples are scanned by X-ray microtomography using a Skyscan-1172 high-resolution desk-top micro-CT system (Skyscan, Kontich, Belgium). The cone beam source operated at 100 kV, using an aluminium filter. The detector configuration, i.e. 1048×2000 pixels 16-bit X-ray camera, and the distance source-object-camera were adjusted to produce images with a pixel size of 17 μm. This resolution allows us to visualize both meso- and macro- porosity. In this study, half the samples were placed under a 15000 kPa pressure (corresponding pressure for the wilting point) in Richards' apparatus in order to empty the meso- and macro-porosity. To determine a priori the class of porosity for the samples, relations between water retention and pressure head can be plotted using this apparatus. Scanning results consist in 2D images. The 2D images are recombined to form 3D structure. Then the pore network can be analyzed through useful factors like size distribution, shape, connectivity, orientation, tortuosity etc.

The oral presentation will report the first analysis results of images obtained from the microtomographic investigation of soil samples. Soil sampling and scanning methods will be detailed. Main porosity parameters will be discussed, soil's structure will be defined, and finally differences according to the agricultural practices will be put in evidence.