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Temporal changes of hydraulic conductivity of cultivated soil studied with help of multipoint tension infiltrometer and X-ray computed tomography

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Soil aggregates, its shape, size and spatial distribution affect the pores arrangement and thus govern the hydraulic conductivity of soil and soil moisture regime. On arable lands the soil is exposed to rapid structural changes within each growing season due to agrotechnical practices, quick crop and root growth, soil biota and climatic conditions. This contribution is mainly focused on temporal changes of unsaturated hydraulic conductivity of cultivated soil. The research is supplemented by detailed analysis of CT images of soil samples for better understanding of structural change of soil during the year and its impact on soil hydraulic conductivity.

The infiltration experiments were done using automated multipoint tension infiltrometer recently developed at CTU in Prague on the plots located on the Nucice experimental catchment. The catchment is situated in a moderately hilly area in central Bohemia (Czech Republic). Fourteen regular infiltration campaigns (77 individual infiltration experiments) were conducted from October 2012 until July 2015 on a single arable plot. In general, agricultural practice captured involved complete life cycle from sowing, through harvest, to postharvest stubble breaking. Weather conditions during infiltration experiments ranged from clear-sky to light rain, with temperatures between 8 and 30°C. All measurements were consistently performed with small suction of 3 cm and hydraulic conductivities were determined using extended semiempirical estimation procedure of Zhang.

Results show that unsaturated hydraulic conductivity was the lowest in early spring and did increase at beginning of summer in the years 2012 - 2014. During the summer and autumn (2012 – 2014) the unsaturated hydraulic conductivity remained relatively unchanged. On the contrary, results in the year 2015 show opposite trend – the highest hydraulic conductivity was observed in early spring and did gradually decrease until the end of July. In both cases, however, the relationship between the soil bulk density and hydraulic conductivity was detected – in general unsaturated soil hydraulic conductivity was higher when the soil bulk density was high. Differences in trends of unsaturated hydraulic conductivities in the years 2012 – 2014 and year 2015 were probably caused by different agricultural management. In years 2012 – 2014, ploughing and sowing (2012 - winter barley, 2013 – oat, 2014 – winter wheat) were carried out in autumn whereas in year 2015 they were done in spring (white mustard). The impact of individual agricultural procedures was not fully apparent in the dataset. New useful information on underlying changes of pore geometry that affected the hydraulic conductivity should be obtained from detailed analysis of X-ray computed tomography images that is currently being performed.