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Using the dye tracer for visualization of preferential flow in macro and micro-scale

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Study is focused on the visualization of the preferential flow in different soil types and their horizons using the dye tracer experiment. Study was performed in the Haplic Luvisol in Hněvčeves and the Haplic Cambisol in Humpolec in the Czech Republic. The 100 (Haplic Luvisol) and 50 (Haplic Cambisol) liters of solute of dye Brilliant Blue FCF (5g/litr) was infiltrated on a 1 x 1 m plot (applying an initial ponding depth of 10 and 5 cm, respectively) immediately after the wheat harvest. On the next day, one half of the plot was sliced horizontally and another half vertically to study the dye distribution within the soil profile to the depth of 100 cm (macro-scale). The 3-D image of the dye distribution was created. In addition, the thin soil sections were made and micromorphological images were used to study a soil aggregate structure and dye distribution in micro-scale.
The staining patterns within the vertical and horizontal sections documented very different nature of the preferential flow in different soil types and also within the soil profiles. Images of the Haplic Luvisol showed that while dye tracer was partly regularly transported and only some isolated domains were visible in the surface Ap1 horizon, the preferential flow occurred in the subsurface horizons. The preferential flow in the upper subsurface Ap2 horizon (plow pan) was caused by the gravitational biopores in the very compact matrix structure, which considerably slowed down the dye transport. In the case of deeper horizons (Bt1 and Bt2), the preferential flow occurred due to the gravitational biopores and extensively developed prismatic structure (small and very large aggregates in the Bt1 and Bt2 horizon respectively), which was highly affected by clay coatings. Even better characterization of the preferential flow particularly in these two horizons was obtained, when the same ponding dye infiltration experiment was performed directly on the top of the Bt1 horizon. Images of the Haplic Cambisol showed that the dye tracer transport in the Haplic Cambisol was in all horizons (Ap, Bw, C) mainly affected by the preferential flow caused by the gravitational fractures and biopores.
The micromorphological images of the Haplic Luvisol soil samples showed higher-order aggregates of the Ap1 horizon, dense structure of the Ap2 horizon, well-developed soil structure affected by clay coatings of the Bt1 horizon and isolated pores with clay coatings inside the large aggregates of the Bt2 horizons. Aggregates in all horizons (Ap, Bw, C) of the Haplic Cambisol were poorly developed. The pore system did not show intrapedal or interpedal pores, pores were developed mainly along gravel particles. Correspondingly to the different soil structure compositions, dye tracer was differently distributed in the soil. Images did not show a regular dye distribution. It was evident that the dye was primarily distributed either in the interagregate pores and then in the pores inside the aggregates, or in the isolated large pores connected to the dye source and then into the matrix pores. Accumulated organic matter, clay coating, larger soil grains and isolated larger capillary pores, which initially did not contain the dye tracer, behaved as less-permeable or impermeable barriers.

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