Geophysical Research Abstracts, Vol. 7, 03688, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03688

Estimation of water retention and transport parameters in structured soils

L. Lichner (1), A. Cipakova (2), V. Stekauerova (1), P. Dlapa (3), B. Houskova (4), M. Sir (5), M. Tesar (5), V. Nagy (1)

(1) Institute of Hydrology, Slovak Academy of Sciences, Racianska 75, 83102 Bratislava, Slovakia, (2) Regional Public Health Authority, Ipelska 1, 04220 Kosice, Slovakia, (3) Dept. Soil Science, Comenius University, Mlynska dolina, 84215 Bratislava, Slovakia, (4) Soil Science and Conservation Research Institute, Gagarinova 10, 82713 Bratislava, Slovakia, (5) Institute for Hydrodynamics, Academy of Sciences of the Czech Republic, Pod Patankou 5, 166 12 Praha 6, Czech Republic. (lichner@uh.savba.sk)

Water, non-reactive chemicals, and reactive the chemicals adsorbed on the soil particles $<$ 0.01 mm can bypass much of the soil matrix via preferential paths. The preferential paths for water flow and solute transport in the unsaturated zone of soil are the hydrologically effective (= surface vented) macropores: biopores (e.g. earthworm, ant, and root holes), inter-aggregate pores, and desiccation cracks. The share of flow through the surface vented macropores can be assessed using the bypassing ratio *BR*, which is defined as a ratio of the rate of macropore flow to the rate of total (macropore and matrix) flow.

Radioactive tracer techniques were used for in-situ measurements of radioactive tracer concentration (activity, counting rate) vs. depth distribution, as well as for laboratory measurements of cadmium sorption and partitioning between reversible and irreversible fractions. The mean penetration depth of tracer (solute), bypassing ratio and soil-water retention capacity were estimated from the results of field measurements with radioactive tracer techniques, tensiometers, double-ring infiltrometer and disc permeameter (suction infiltrometer), as well as laboratory measurements on undisturbed soil columns with falling head permeameter. Cadmium sorption on all soil particles was measured with the standard batch technique, and that on the particles $<$0.01 mm (easily mobile in soil macropores) with the modified batch technique using radioactive cadmium ^{109}Cd as a tracer in both techniques. Cadmium partitioning

between reversible and irreversible fractions was estimated with the modified Tessier sequential extraction procedure using radioactive cadmium ^{109}Cd as a tracer, too.

Ease and speed of measurements are the most significant advantages of radioactive tracer techniques. One point in the concentration vs. depth distributions requires one minute only, installation or removal about 10 minutes per probe. When used in a field soil, the radioactive tracer technique is non destructive and able to locate heterogeneities. The dose of radioactive tracer necessary for one plot is very small and in the case of radioactive iodine ^{131}I it is one sixth of the dose used in thyroid gland therapy.

Soil parameters were estimated in six sites in southwestern Slovakia (Bodiky, Gabcikovo, Jurova, Kalinkovo, Macov, and Most), and one site in southern Bohemia (Zabrod). Susceptibility of soils to deep penetration of cadmium was assessed on light, loamy-sand soil in Kalinkovo, medium heavy, loamy soil in Macov, and heavy, clay soil in Jurova. It was found that when the interaction between soil and cadmium lasted 1 minute, more than 35%, 32%, and 48% of cadmium was adsorbed on the particles < 0.01 mm in soils from Kalinkovo, Macov, and Jurova, respectively. A change in cadmium partitioning between soil particles < 0.01 mm and particles > 0.01 mm was found with an increase in the duration of cadmium – soil contact in all studied soils. A drop in the cadmium sorption on particles < 0.01 mm was accompanied with an increase in the cadmium sorption on particles > 0.01 mm. Similar change in cadmium partitioning between reversible and irreversible fractions was found with an increase in the duration of cadmium – soil contact. A drop in the cadmium reversible fraction was accompanied with an increase in the cadmium irreversible fraction.

Temporal variations of *BR* observed under different crops in the vegetation seasons 2000 and 2001, have the span 76.8–98.2% (winter wheat) and 47.7–82.6% (oil-seed rape) in Kalinkovo, 53.6–98.2% (winter wheat) and 45.5–93.4% (maize) in Macov, and 89.2–99.8% (winter wheat) and 87.5–99.6% (maize) in Jurova, respectively. The bypassing ratio was estimated from two to five measurements of the saturated hydraulic conductivity with double-ring infiltrometer and the hydraulic conductivity k(–3 cm) with disc permeameter at each site and on each day. Minimal values of the bypassing ratio *BR* were highest in all three soils under winter wheat.

The bypassing ratio of soil under maize and millet in Gabcikovo was estimated from the measurements of saturated hydraulic conductivity with falling head permeameter and the hydraulic conductivity k(–1.7 cm) with disc permeameter. The bypassing ratio of soil under maize (*BR* = 88.7%) was lower than that under millet (*BR* = 97.6%).

Cadmium penetration into a sandy-loam soil under meadow during the field ponded infiltration at Bodiky (Kralovska luka meadow) site was observed in a controlled ex-

periment. Quite deep ^{115}Cd penetration (65 cm beneath the soil surface) gives evidence of the particle-facilitated transport of cadmium through preferential pathways. More than 40% of the applied cadmium penetrated deeper than 10 cm. Transport of cadmium adsorbed on soil particles < 0.01 mm was examined using radioactive tracer techniques in laboratory batch tests. Soil particles smaller than 0.01 mm were found to be responsible for 66% of the adsorbed amount of cadmium.

The water retention capacity of a soil under meadow was estimated in the Zabrod experimental field in the Sumava Mts. from the results of field infiltration tests. The counting rate vs. depth distributions were measured during an infiltration of water marked with radioactive iodine ^{131}I. It was found from the cumulative counting rate vs. cumulative infiltration relationship that the water retention capacity of that soil is about 60–75 mm.

Effect of plant cover on the transport and retention properties of a soil depends on plant genus and growth in the course of vegetation season. As this effect can be overlaid with an effect of cultivation, it could be assessed *ceteris paribus* (under identical remaining conditions).