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SOLUTE TRANSPORT IN CLAY-LOAM SOIL WITH AND WITHOUT MACROPORES

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In the years 1993-1996 the measurements of solute transport were made in caly-loam at the Experimental Station of the Research Institute of Irrigation in Most near Bratislava. The measurements of water flow and solute transport were performed by means of nuclear tracer technique. TDR moisture meters, tensiometers, and phase transmission moisture meters.

The plots 1 m x 1 m (1995-96), 1 m x 4 m (1993), and 4 plots 3 m x 3 m (1994) were used to study the radioactive iodide $^{131}I^-$ transport in the soil. The plot in 1993 experiment and 2 plots in 1994 experiment were sown with barley, the plot in 1995 experiment with maize, and 2 plots in 1994 experiments and the plot in 1996 experiment were not tilled, covered with grass. Two different methods of tracer application were used: in the first one a few drops of radioactive solution were applied to the 10 cm diameter ring around each probe (1993-94). In the second method radioactive solution was applied by the sprinkling irrigation (1995-96). Non-active iodine in the form NaI was added to prevent $^{131}I^-$ from incorporation into organic compounds. After infiltration of the radioactive tracer solution, water was applied by the sprinkling irrigation with intensity ranged from 2 mm/h (1994) to 24 mm/h (1996). All these intensities exceeded laboratory values if the matrix saturated hydraulic conductivity 0.2-1 mm/h and therefore, the first condition of macropore flow was fulfilled.

Dry-access observation tubes (130 mm length x 8 mm I.D.), in which a Geiger-Mueller detector connected to the nuclear analyser can be placed in the preselected location, were inserted vertically to the depth of 110 cm (1993-96) and horizontally at the depth of 30 cm (1996). The transport of $^{131}I^-$ as a non-reactive tracer was monitored in the neighbourhood of those tubes. Two types of results can be obtained by means of this through-the wall measurement technique, namely tracer concentration distribution versus depth and tracer concentration distribution versus time (break- through curve). Owing to its size (21-mm length x 6.3-mm O.D.) the Geiger-Mueller detector can be viewed as a point detector.

Statistical treatment of the tracer measurements covered the cumulative infiltration in which breakthrough curve peaked, the depth in which the concentration distribution versus depth peaked, and the penetration depth of $^{131}I^-$. It showed that the breakthrough curves peaked after nearly the same cumulative infiltration of 10.3 ± 3.9 cm and 9.8 ± 3.7 cm in 1993 and 1996 experiment, respectively. It happened in spite of different agricultural treatment (tilled field with barley vs. no-till meadow) and different intensity

of sprinkling irrigation (10 mm/h vs. 24 mm/h) in 1993 and 1996 experiment, respectively.

In addition to this the tracer measurements showed that after infiltration and redistribution of 27 mm of the $^{131}I^-$ solution in structured clay-loam soil at the field with maize (1995), radioactive iodine was monitored at the depth up to 40-50 cm. After infiltration and redistribution of additional 81 mm of water, the penetration depth of $^{131}I^-$ was 70-90 cm. Similar measurements at no-till clay-loam soil covered with grass showed the $^{131}I^-$ penetration up to the depth of 70-80 cm immediately after infiltration of 18 mm of the $^{131}I^-$ solution (1996). After infiltration and redistribution of additional 162 mm of water, the penetration depth of $^{131}I^-$ was 90-100 cm. These results demonstrate the predominance of macropore flow up to the depth of about 40-60 m in 1995 experiment and 70-80 cm in 1996 experiment, and the predominance of matrix flow in deeper depths.

Effectiveness of macropore system (i.e., relationship between the water bypassing the matrix and water engaged in the matrix flow) could be evaluated, e.g., by a dose of water necessary to lower the $^{131}I^-$ penetration depth by 10 cm. The dose was of about 100 mm, 27 mm, and 90 mm in 1993, 1995 and 1996 experiment, respectively. This quantity is of great importance in irrigation practice and reclamation of saline soils.

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