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Water and Solute Flow in a Highly-Structured Soil

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- Full Text

Prevention of groundwater contamination by agricultural activities is a high priority in the United States. Water and contaminants often follow particular flow paths through the soil that lead to rapid movement of pesticides out of the rootzone. An improved understanding of why water and solute follow particular flow paths is needed to identify soils that allow agricultural chemicals to move rapidly to groundwater. The rate that water and contaminants are transferred from the soil surface to groundwater may be related to the degree of flow path channelization (convergence or divergence of water flow paths). This project was designed to test the feasibility of measuring the degree of channelization as water percolates through structured soils. A flow interceptor device consisting of 98 individual 25 by 25 mm cells operating under tension was constructed for this purpose.

Water flux probability density distributions (pdd's) were measured at 0.3, 0.6 and 0.9 m depth in Ships clay (very-fine, mixed, thermic, Chromic Udic Haplusterts). Water flux and solute travel time pdd's were measured at 0.3, 0.9 and 1.2 m in Silawa loamy fine sand (fine-loamy, siliceous, thermic, Ustic Haplusterts). Both probability distributions were fitted with log-normal functions. In Ships clay, water flow paths converged as water moved from 0.3 to 0.9 m depth, while in Silawa loamy fine sand flow paths converged from 0.3 to 0.9 and diverged from 0.9 to 1.2 m depth. This convergence and divergence of water flux in the soil was related to changes in structural definition with depth. Convergence of water and solute flow is expected to increase the pollution potential of the soil because of increased bypassing of soil matrix and increased pore water velocities.

Solute travel time pdd's for Silawa at 0.9 and 1.2 m depth were predicted with a stochastic transfer function model calibrated at 0.3 and 0.9 m depth, respectively, and compared to the actual measured travel time pdd's at 0.9 and 1.2 m. From this it was concluded that water flux measurements at the surface alone are, in general, not a suitable way to predict water and solute fluxes at lower depths.

Spatial variability of water fluxes and bromide fluxes were highly correlated, and the coefficient of variation of both depended on the horizon in which the measurements were taken.

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