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# Numerical modeling of Nitrate movement through unsaturated porous media using mobile-immobile approach

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The aim of this study is to investigate the nitrate transport through vadose zone using large scale laboratory and simulation experiments considering mobile-immobile regimes. A three dimensional sand tank of L-60 cm × W-30 cm × D-60 cm was fabricated to conduct the laboratory experiments. The sand tank setup is made up of 0.7 mm thick glass sheet embedded with three horizontal layers of sampling ports having vertical distance of 14 cm. A porous medium having grain size of 0.5-1.0 mm free from organic content was packed homogeneously for conducting steady state experiments. A constant flux of 150 mL/hr. having 300 ppm nitrate concentration was allowed to flow in vertical direction. The pore water samples were collected hourly from the sampling ports and were analysed using spectrophotometer.. HYDRUS 3D simulation was conducted of same domain size incorporating single porosity model and dual porosity model having 15% and 20% mobile regimes. The observed breakthrough curves (BTCs) at different ports shows the higher cumulative nitrate flux at bottom in tank setup than 15% mobile domain followed by 20% mobile domain. Similarly, the bottom equilibrium nitrate concentration is higher in laboratory setup than 15% mobile domain followed by 20% mobile domain. This higher nitrate flux and concentration at bottom is due to less sorption and more restriction of vertical movement of flux in laboratory tank, which is nearby the 15% mobile domain than increasing degree of mobility. The nitrate sorption at bottom observation nodes were computed and its shows maximum sorption in single porosity than 20 % mobile followed by 15 % mobile regions during simulation of nitrate movement through vadose zone for entire time duration. Overall, the sand tank experiment results well matched to domain considering dual porosity approaches with 15 % mobile regions. Further, the mass balance analysis reinforces the domination of nitrate flux to underlying groundwater resources. The results of this study may help in protection of groundwater resources from vadose zone return flows and can be used directly in planning of remediation strategies for the polluted sites.