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Flow and Transport of Radionuclides in the Rhizosphere: Imaging and Measurements in a 2D System

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This research aims to build upon past 2D tank light transmission methods to quantify real-time flow in unsaturated porous media, understand how exudates effect unstable flow patterns, and understand radionuclide mobility and dispersion in the subsurface. A 2D tank light transmission method was created using a transparent flow through tank coupled with a random rainfall simulator; a commercial LED light and a CMOS DSLR Nikon D5500 camera were used to capture the real-time flow images. The images were broken down from RGB into HVI and analyzed in Matlab to produce quantifiable data about finger formation and water saturation distribution. Radionuclide locations were determined via handheld gamma scanner. Water saturation along the vertical and horizontal profile (Matlab) was used to quantify the finger more objectively than by eye assessment alone. The changes in finger formation and speed of propagation between the control rain water (0.01M NaCl) and the solutions containing plant exudates illustrates that the plant exudates increased the wettability (mobility) of water moving through unsaturated porous media. This understanding of plant exudates effect on unsaturated flow is important for works studying how plants, their roots and exudates, may affect the mobility of radionuclides in unsaturated porous media. As there is an increase in exudate concentration, the mobility of the radionuclides due to changing flow pattern and available water content in porous media may be improved causing more dispersion in the porous media and intake into the plant. Changes in plant root exudation impact the distribution and density of radionuclides in the rhizosphere and vadose zone.