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Laboratory Column Experiments on the Transport of E. coli to Subsurface Drains by Macropore Flow

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Abstract:

The primary transport of pathogenic microorganisms in soils occurs through macropores that bypass the filtering and adsorptive effects of the soil. Recent research indicates immediate breakthrough of contaminants in subsurface drainage by extraordinarily efficient transport through directly connected macropores. In this study, an innovative soil column packed with loamy sand (LS) and sandy clay loam (SCL) soils was used to simulate the transport of E. coli through directly connected macropores into subsurface drainage systems. Ten experiments simulating open surface connected and buried macropores were performed. The soil column was flushed with distilled water, diluted swine manure, and finally with distilled water at 0, 48, and 96 hours, respectively, after packing. Both open surface connected and buried macropores were capable of transporting E. coli to the subsurface drain. During the manure flushing, the breakthrough time in both discharge and E. coli recovery was inversely proportional to the macropore length. In buried macropores, E. coli detection occurred simultaneously with macropore discharge breakthrough. For open surface connected macropores that extended the entire distance between the soil surface and drain except for the last 10 to 20 cm, the maximum E. coli concentrations in the drain flow with LS was approximately 20 to 30% of the inflow E. coli concentration, and lest than 0.05% in the SCL experiments. For buried macropores, maximum E. coli concentrations in the drain flow for the LS experiments were approximately 10% of the initial concentration but 25 to 40% in the macropore. For the SCL experiments, the E. coli recovery in the drain was lower than 0.003% of the initial concentration and lower than 0.03% in the macropore flow. The findings of this study stress the importance of directly connected macropores to subsurface drainage systems, especially for rainfall events or irrigation shortly after manure application.

Impact Statement:

The findings of this study stress the importance of directly connected macropores on transport of E. coli to subsurface drainage systems, especially for rainfall events or irrigation shortly after manure application. The study also demonstrates that for these packing conditions both surface connected and buried macropores can contribute in E. coli transport.

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