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Paddy soil cracks: characteristics and their impact on preferential flow

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Paddy soils with harrowing and puddling easily crack under alternate flooding and drying cycles (AFD). These cracks in paddy field may become pathways of preferential flow, improving water infiltration and increasing the pollution risk of groundwater. The objectives of this study were to investigate the 2D and 3D characteristics of soil cracks in paddy fields; and to determine their impacts on preferential flow. Two paddy fields, one cultivated for 20 years (YPF) and the other cultivated for more than 100 years (OPF), were subjected to either alternate flooding and drying (AFD) or continuous flooding (CF) during rice growing season. After the harvest of late rice crop, soil surface cracks were recorded using digital camera; and 3D structure of soil cracks was scanned by computed tomography (CT). The characteristics of 2D and 3D soil cracks were quantified with the aid of image analysis. The influence of soil cracks on preferential flow was characterized by tension infiltrometer, dye tracer and ion breakthrough curve. Our main results in this study were summed up as follows: under AFD condition, for the 2D soil cracks, the YPF presented 10 fold more cracks in quantity but these cracks were finer and more complicated as compared to those generated in the OPF. The results of CT scanning showed that the presence of soil cracks under the AFD increased average macropore length but decreased the number of macropores significantly, and it also changed macropore size distribution and macropore area density distribution with soil depth. The 3D structures of soil cracks were complicated but can be quantified using CT. The depth of soil cracks in young paddy field (7.58 cm) was smaller than that in old paddy field (9.34 cm), but soil cracks in both fields did not reach the plough pan (about 15 cm). Soil cracks significantly increased soil hydraulic conductivity. They serviced as pathways for preferential flow only in plow layer, as evidenced by a large dyed area above plough pan but a small area below it. Both the shape of BTCs and fitting parameters demonstrated that soil cracks did not increase preferential flow below plow pan because they did not perforate through the dense plow pan.
This study demonstrates that soil cracks in paddy fields significantly affect macropore structure but their impact on preferential flow may be poor when they do not penetrate through the plow pan.