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Rill flow velocity affected by the subsurface water flow depth of purple soil in Southwest China

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Subsurface water flow above the weakly permeable soil layer commonly occurs on purple soil slopes. However, it remains difficult to quantify the effect of subsurface water flow on the surface flow velocity. Laboratory experiments were performed to measure the rill flow velocity on purple soil slopes containing a subsurface water flow layer with the electrolyte tracer method considering 3 subsurface water flow depths (SWFDs: 5, 10, and 15 cm), 3 flow rates (FRs: 2, 4, and 8 L min^{-1}), and 4 slope gradients (SGs: 5°, 10°, 15°, and 20°). As a result, the pulse boundary model fit the electrolyte transport processes very well under the different SWFDs. The measured rill flow velocities were 0.202 to 0.610 m s^{-1} under the various SWFDs. Stepwise regression results presented the positive dependence of the flow velocity on FR and SG but a negative dependence on SWFD. SWFD had notable effects on the rill flow velocity. Decreasing the SWFD from 15 to 5 cm increased the flow velocity. Moreover, the flow velocities under the 10- and 15-cm SWFDs were 89% and 86%, respectively, of that under the 5-cm SWFD. The flow velocity under the 5-, 10- and 15-cm SWFDs was decreased to 89%, 80%, and 77%, respectively, of that on saturated soil slopes. The results will enhance the understanding of rill flow hydrological processes under SWFD impact.