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Estimating the saturated soil hydraulic conductivity by the near steady-state phase of a beerkan infiltration run

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Simple infiltration experiments carried out in the field allow an easy and inexpensive way of characterizing soil hydraulic behavior, maintaining the functional connection of the sampled soil volume with the surrounding soil. The beerkan method consists of a three-dimensional (3D) infiltration experiment at zero pressure head (Haverkamp et al., 1996). It uses a simple annular ring inserted to a depth of about 0.01 m to avoid lateral loss of the ponded water. Soil disturbance is minimized by the limited ring insertion depth. Infiltration time of small volumes of water repeatedly poured on the confined soil are measured to determine the cumulative infiltration. Different algorithms based on this methodology (the so-called BEST family of algorithms) were developed for the determination of soil hydraulic characteristic parameters (Bagarello et al., 2014a; Lassabatere et al., 2006; Yilmaz et al., 2010). Recently, Bagarello et al. (2014b) developed a Simplified method based on a Beerkan Infiltration run (SBI method) to determine saturated soil hydraulic conductivity, K_s, by only the transient phase of a beerkan infiltration run and an estimate of the α* parameter, expressing the relative importance of gravity and capillary forces during an infiltration process (Reynolds and Elrick, 1990). However, several problems yet arise with the existing BEST-algorithms and the SBI method, including (i) the need of supplementary field and laboratory measurements (Bagarello et al., 2013); (ii) the difficulty to detect a linear relationship between I / $\sqrt{t}$ and $\sqrt{t}$ in the early stage of the infiltration process (Bagarello et al., 2014b); (iii) estimation of negative K_s values for hydrophobic soils (Di Prima et al., 2016). In this investigation, a new Simplified method based on the analysis of the Steady-state Beerkan Infiltration run (SSBI method) was proposed and tested. In particular, analytical data were generated to simulate beerkan infiltration experiments for six contrasting soils (sand, S; loamy sand, LS; sandy loam, SAL; loam, L; silt loam, SIL and silty clay loam, SCL) from UNSODA database and different initial water contents. Comparison with other existing procedures were also carried out. The SSBI method allowed accurate estimation of saturated soil hydraulic conductivity of both field and analytically generated data. For analytically generated data, the most accurate predictions were obtained with the method 2 by Wu et al. (1999) for the S and LS soils (prediction errors not exceeding 3.8%) and with the SSBI method for the other four soils (error < 3.7%). Therefore, this last method performed better than the other tested methods in most cases. The analysis of the field data supported the usability of the SSBI method in different environments and conditions to obtain an acceptable prediction of K_s, i.e. similar to the one that can be obtained with the BEST-steady algorithm (Bagarello et al., 2014a). Finally, this investigation yielded encouraging signs on the applicability of the SSBI method for a trustworthy estimation of K_s by the near steady-state phase of a beerkan infiltration run.

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