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Hydraulic characterization of a sealed loamy soil in a Mediterranean vineyard

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Water infiltration measurements constitute a common way for an indirect characterization of sealed/crusted soils (Alagna et al., 2013). The Beerkan Estimation of Soil Transfer (BEST) parameters procedure by Lassabatere et al. (2006) is very attractive for practical use since it allows an estimation of both the soil water retention and hydraulic conductivity functions. The BEST method considers certain analytical formulae for the hydraulic characteristic curves and estimates their shape parameters, which are texture dependent, from particle-size analysis by physical-empirical pedotransfer functions. Structure dependent scale parameters are estimated by a beerkan experiment, i.e. a three-dimensional (3D) field infiltration experiment at ideally zero pressure head. BEST substantially facilitates the hydraulic characterization of unsaturated soils, and it is gaining popularity in soil science (Bagarello et al., 2014a; Di Prima, 2015; Di Prima et al., 2016b). Bagarello *et al*. (2014b) proposed a beerkan derived procedure to explain surface runoff and disturbance phenomena at the soil surface occurring during intense rainfall events. Di Prima *et al*. (2016a) applied this methodology in a vineyard with a sandy-loam texture. These authors compared this simple methodology with rainfall simulation experiments establishing a physical link between the two methodologies through the kinetic energy of the rainfall and the gravitational potential energy of the water used for the beerkan runs. They also indirectly demonstrated the occurrence of a certain degree of compaction and mechanical breakdown using a minidisk infiltrometer (Decagon, 2014). With this device, they reported a reduction of the unsaturated hydraulic conductivity by 2.3 times, due to the seal formation. The ability of the BEST method to distinguish between crusted and non-crusted soils was demonstrated by Souza *et al*. (2014). However, the potential of the beerkan runs to detect the effect of the seal on flow and BEST estimates is still largely unknown since only a few investigations have been carried out. In this study, the BEST method was applied to check the impact of sealing on soil hydraulic conductivity in a Mediterranean vineyard (western Sicily, Italy) under conventional tillage. An area of approximately 150 m^2 was sampled on three different sampling campaigns covering two growing seasons. Beerkan infiltration experiments were carried out along the rows direction and in the inter-row areas. A 55 mm rainfall event that occurred between the first and second sampling campaigns contributed to form a sealed layer at the soil surface. The presence of the seal implied that the saturated soil hydraulic conductivity, K_s, was 1.5-1.8 times lower than that measured in the absence of the sealed layer. The seal layer only affected water infiltration between the rows, suggesting that the protective role of vegetation along the rows was effective. The tillage practices carried out in the spring 2016 removed any existing surface sealed layer and thereby increased soil infiltration properties, suggesting a cycling occurrence of layering phenomena within the year. In fact, differences between the K_s values measured between the rows (second against first and third sampling campaigns) were statistically significant. In this investigation, the sampling strategy implying beerkan tests carried out along and between the vine-rows was successfully applied. This strategy allowed to assess the reduction in hydraulic conductivity with extemporaneous measurements alone. Its main advantage is that it allows a rapid assessment of sealing severity affecting water infiltration taking advantage of the protective role of the vegetation along the rows. In conclusion, the hypothesis that the beerkan runs are suitable enough to detect the effect of the seal on flow and K_s values estimated by BEST was reasonable. In the future, testing the proposed procedure in conjunction with others field methodologies for soil hydraulic characterization implying alteration at the soil surface, such as rainfall simulation experiments or the beerkan derived procedure discussed above, should contribute to a better understanding of sealing severity affecting water infiltration on bare soils. Ring insertion for the infiltration run does not seem to alter the sealed layer but more investigations are required with reference to this point.

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