Identification of a temporal variability of soil hydraulic properties under drip irrigation using Beerkan infiltration method

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The identification of a temporal variation in soil hydraulic properties in the course of a cropping season subject to drip irrigation can contribute to the improvement of water use efficiency and the mitigation of adverse environmental effects. Saturated hydraulic conductivity, $K_s$, capillary length, $\alpha_h$, and the characteristic microscopic pore “radius” i.e., the mean characteristic dimension of hydraulically functional pore, $\xi_m$, are fundamental parameters governing water transfer in soil under drip irrigation. Series of 3D infiltration tests, using the Beerkan infiltration method, were carried out on a loamy soil of a corn field drip irrigated in the southern of France. Two treatments: a full (FT) and a limited (LT) treatment were investigated. Seven infiltration measurement sets were taken within each treatment on the top soil layer during the cropping season between June and September. The 1st set of measurements was done before 1st irrigation. At each set, six to eight infiltration measurements were performed on a 9m² pre-selected sub-plot. The results show that for the both irrigation treatments, soil hydraulic properties are strongly affected by the first irrigations. $K_s$ and $\xi_m$ drastically decrease with cumulative water application depth from the first irrigation until the root systems approximately reach its maximal value. Then these two parameters seem to re-increase slowly with time. Capillary length has an inverse behavior of these
two parameters. At the first times, this temporal evolution could be due to the soil re-
struction process under irrigation. While, at the end of irrigation season, where
irrigation decreased due to lower water requirements for the both treatments, the irri-
gation effect was overlaid by the biological activity and the root development effect
creating new channels or continuity between existing pores. Indeed, we found that the
variations with time in these soil properties are in agreement with the temporal evolu-
tion of bulk density during the crop season. The processes affecting these properties
are similar for both irrigation treatments, but with a different response intensity. For
the measurements covering the irrigation season, limited drip irrigation treatment (LT)
presents higher mean values for both $K_s$ and $\xi_m$ and smaller mean values of capillary
length, $\alpha_h$, than those of the full irrigation treatment (FT). This can be due to the
different water amounts applied to the treatments especially at the beginning of the
irrigation season. This can be also attributed to the alternated daily effects of wetting
and drying cycles of the soil during limited treatment (LT). As a consequence of ir-
rigation and root development, soil hydraulic properties showed a dynamic evolution
in time. This state of fact raises the question about the interest to take into account
this phenomenon for improving water use efficiency. Modelling could be a first step to
assert if yes or not the evolution of the soil parameters merit to be taken into account
in the course of a cropping season to improve water management and to mitigate the
environment risks under drip irrigation.