EGU24-8199, updated on 21 Mar 2024
https://doi.org/10.5194/egusphere-egu24-8199
EGU General Assembly 2024

Comparing Hydrus-2D/3D and Philip (1984)'s model to assess wetting bulb expansion from buried and surface point sources

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In surface and subsurface drip irrigation systems, predicting the size expansion of the wetting bulb and the irrigation time are mandatory for water saving, and help drive their design and scheduling. At this aim, different hydrological models have been suggested to predict the wetting bulb expansion from buried and surface point sources. In this work, we compare the results obtained by the application of Hydrus-2D/3D and Philip (1984) model.

The Philip (1984) model accounts for the Gardner conductivity function, which is not implemented in Hydrus 2D/3D. Moreover, in the Philip (1984) model, a certain approximation in the choice of the water contents to be used for calculating the average volumetric water content behind the wetting front, θ_{av}, is necessary, also considering that definitions do not seem univocal. For example, the water content at the wetting front was assumed as the θ_{av}, value when soil hydraulic conductivity, K, was equal to 1 mm/day by Cook et al. (2003) and 1 mm/h by Thorburn et al. (2003).

For the purpose of the comparison, an extended analysis aiming at detecting the parameter ranges of the van Genuchten-Mualem model (van Genuchten 1980), which provide hydraulic conductivity functions matching those of Gardner, was preliminary conducted. Then, for van Genuchten-Mualem parameters falling in such parameters' ranges, the average volumetric water content that is required in the Philip (1984) model was calculated in Hydrus-2D/3D.

For sandy-loam soil, results showed a quite good agreement between the simplified Philip (1984) model and the more accurate but numerically demanding Hydrus 2D/3D, suggesting that Philip (1984)'s model can be successfully applied to predict the wetting bulb expansion from buried and surface point sources, provided the average volumetric water content in the soil behind the wetting front and the saturated hydraulic conductivity are appropriately considered.

Keywords: wetting bulb, buried sources, surface sources, Philip (1984)'s model, Hydrus 2D/3D.

Acknowledgement: This study was carried out within the RETURN Extended Partnership and received funding from the European Union Next-GenerationEU (National Recovery and Resilience Plan – NRRP, Mission 4, Component 2, Investment 1.3 – D.D. 1243 2/8/2022, PE0000005).

References:

Cook, F.J., P.J., Thorburn, K.L., Bristow, and C.M., Cote, "Infiltration from surface and buried point

sources: The Average wetting water content", Water Resour. Res., 2003, 39(12): 1364, doi:10.1029/2003WR002554.

Philip, J.R., "Travel times from buried and surface infiltration point sources", Water Resour. Res., 1984, 20(7), 990–994, https://doi.org/10.1029/WR020i007p00990.

Thorburn, P.J., F.J., Cook, and K.L., Bristow, "Soil-dependent wetting from trickle emitters: Implications for system design and management", Irrig. Sci., 2003, 22: 121–127, doi 10.1007/s00271-003-0077-3.

van Genuchten, M. Th., "A closed form equation for predicting the hydraulic conductivity of unsaturated soils", Soil Sci. Soc. Am. J., 1980, 44: 892-898.