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Simulation of Soil Wetting Patterns in Drip and Subsurface Irrigation. Effects in Design and Irrigation Management Variables.

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Conventional drip irrigation is considered one of the most efficient irrigation systems. Alternatively to traditional surface drip irrigation systems (DI), laterals are deployed underneath the soil surface, as in subsurface drip irrigation (SDI), leading to a higher potential efficiency, which is of especial interest in places where water is a limited source. The design and management of DI and SDI systems involve selection of an appropriate combination of emitter discharge rate and spacing between emitters and the inlet pressure and irrigation time for any given set of soil, crop, and climatic conditions, as well as understanding the wetted zone pattern around the emitter. Likewise, water distribution is affected by soil hydraulic properties, initial water content, emitter discharge, irrigation frequency, evapotranspiration and root characteristics. However, complexity arousing of soil water properties and soil profile characteristics means that these are often not properly considered in the design and management of those systems.

A better understanding of the infiltration process around the discharge point source should contribute to increase water use efficiency and thus to reduce the risk of environmental impact of irrigation. In this regard, numerical models have been proved to be a powerful tool to analyze the evolution of the wetting pattern during the distribution and redistribution processes, in order to explore irrigation management strategies, to set up the duration of irrigation, and finally to optimize water use efficiency. Also, irrigation design variables such as emitter spacing and discharge could also be assessed. In this study the suitability of the HYDRUS-2D to simulate infiltration process around an emitter during irrigation of a loamy soil with drip and SDI laterals has been addressed. The model was then applied in order to evaluate the main dimensions of the wetted soil volume surrounding the emitter during irrigation.

Irrigation uniformity with DI and SDI laterals were determined by field evaluations at different inlet head pressures. Results were related with estimations made on water distribution within the soil that were simulated taking into account the emitter discharge at different lateral locations, initial soil water content, soil hydraulic properties and time of irrigation. Conclusions highlight the effect of emitter discharge, emitter spacing, and irrigation time on wetting patterns, and thus solute transport, in both drip and subsurface drip irrigation. The effect of emitter depth was also considered in SDI. Some recommendations for the design and management of these irrigation systems are also provided.