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Study of the wet bulb in drip irrigation in stratified soils using HYDRUS

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INTRODUCTION AND OBJECTIVES

The "enarenado" (sand-covering soil) is a technique used in greenhouses located in the southeast of Spain that consists of placing a layer of soil between 20 and 40 cm above the original material, a thin layer of organic matter and above it a layer of sand of about 5 to 10 cm (figure 1).

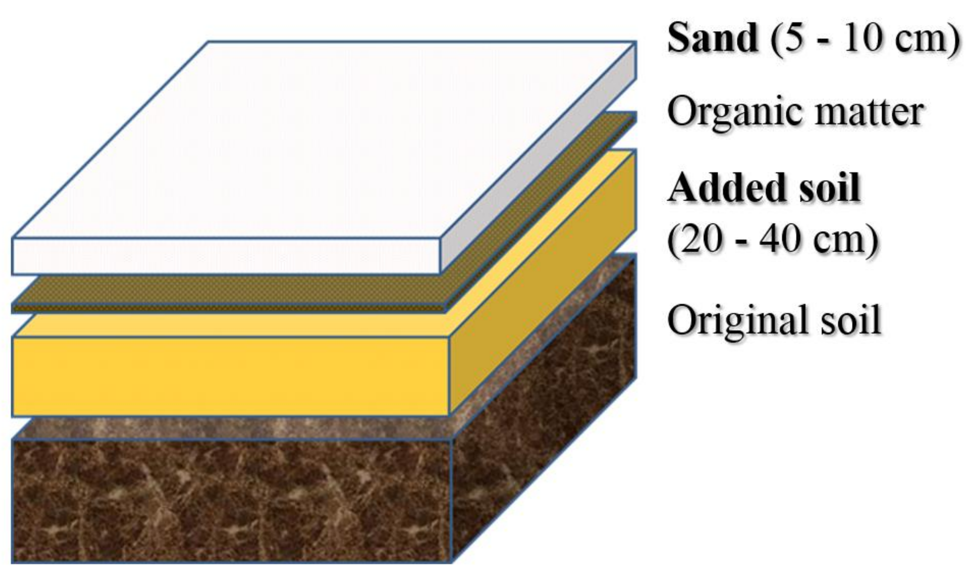

Figure 1. Layers of an "enarenado" soil.

It is necessary to know the shape of the wet bulb produced by the emitters for a correct design and management of the drip irrigation systems. In stratified soils, as in the case of "enarenado" soils, the distribution of water can change substantially with respect to the case of homogeneous soils.

The **objective** of this work is to present the methodology of data acquisition and the actions carried out so far to obtain a model that precisely defines the evolution of humidity in wet bulbs generated in "enarenado" soils characteristic of intensive horticultural crops using the Hydrus model.

MATERIAL AND METHODS

The experiments are carried out at the Andalusian Institute for Agricultural Research and Training (IFAPA Center in La Mojonera, Spain (figure 2).

Figure 2. Experimental greenhouse location

In this phase of the study it has been considered that the soil is homogeneous in each layer and therefore a quadrant of the drip spacing will be controlled. The crop was pepper in the two selected greenhouses:

- Clay-loam soil (greenhouse **B7**)
- Sandy-loam soil (greenhouse **B8**)

Irrigation is automatic, with drippers of nominal flow Q_n = 3 l / h, Self-compensating and Anti-Drainage

It was used Decagon CE5 sensors (capacitance/frequency domain technology).

The soil moisture sensors will be placed at two depths (figure 3):

- just under the sand layer (5 cm depth)
- at the bottom of crop profile (18 cm depth)

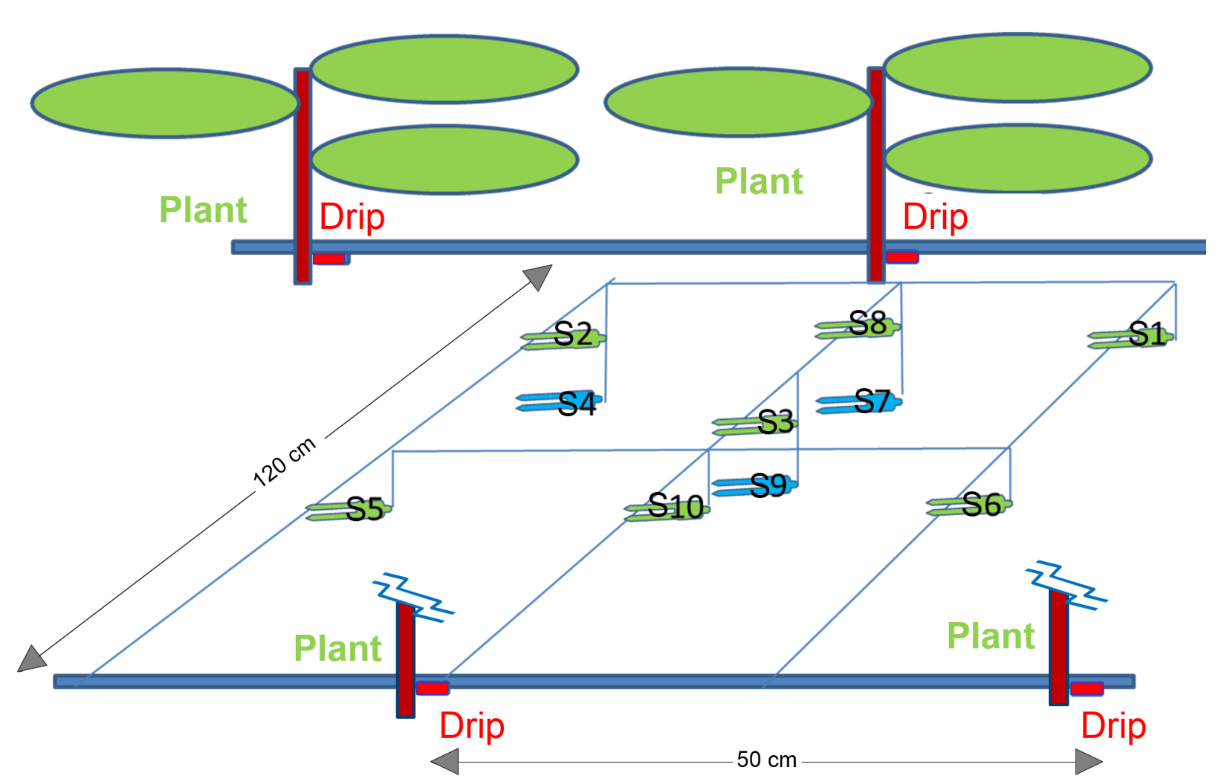

Figure 3. Arrangement and numeration of sensors in the soil

To use the Hydrus model, the texture, root distribution, moisture retention curve, and the saturation hydraulic conductivity and permeability of each proposed material have been characterized.

The expression of the soil moisture retention curve was described via Brooks–Corey model.

$$\frac{\theta_i-\theta_r}{\theta-\theta_r}=\left(\frac{\psi_b}{\psi}\right)^{\lambda}$$

Where θ_r and θ_i are the residual and saturated soil moisture (cm^3/cm^3), ψ represents matric potential (kPa) with ψ_b the air entry value, and λ is an empirical parameter often referred to as the pore size distribution index.

Acknowledgements

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RESULTS AND DISCUSSION

Data collection

The average monthly distribution of moisture has been studied (see figure 4). As it can be seen, in cold months a wet bulb is formed, but from February it start disappears and from March it is imperceptible.

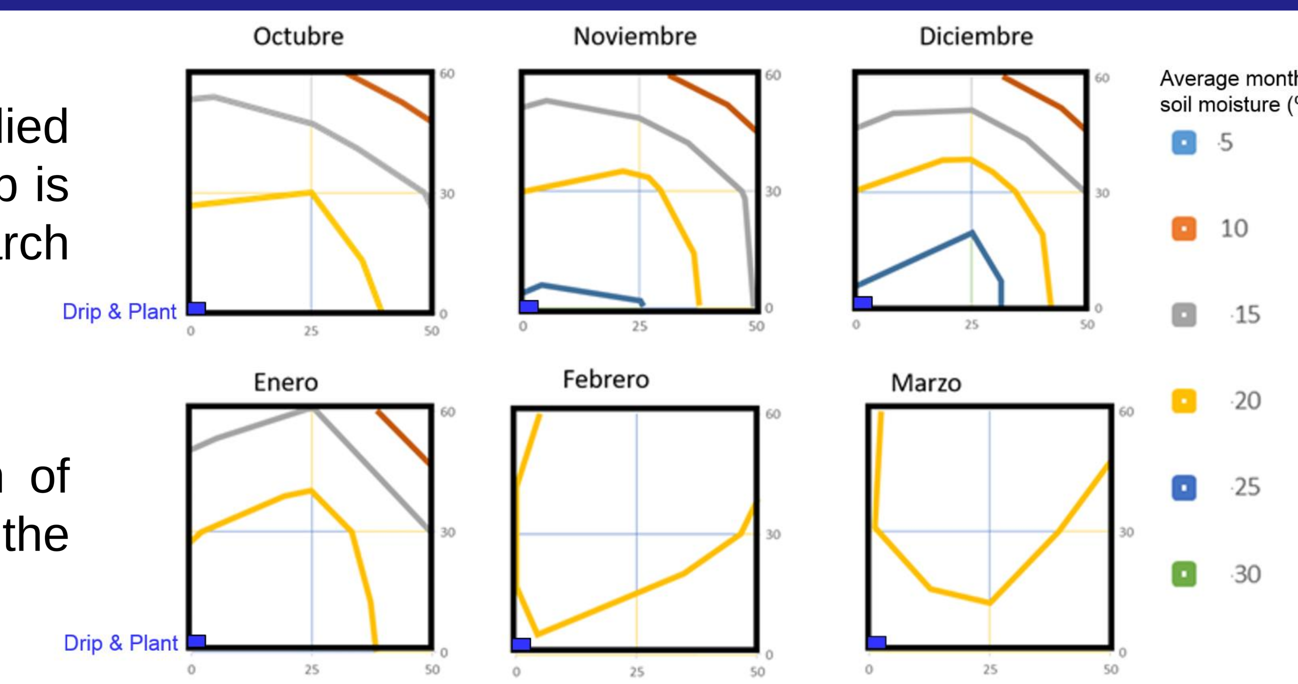

Figure 4. Average monthly moisture (%) in the sampled area. Drips and plants are placed at x=0, y=0. Soil B7

Soils texture

The variation of each particle size fraction as a function of depth is shown in Figure 5. Both soils have differences in the content of the coarse texture.

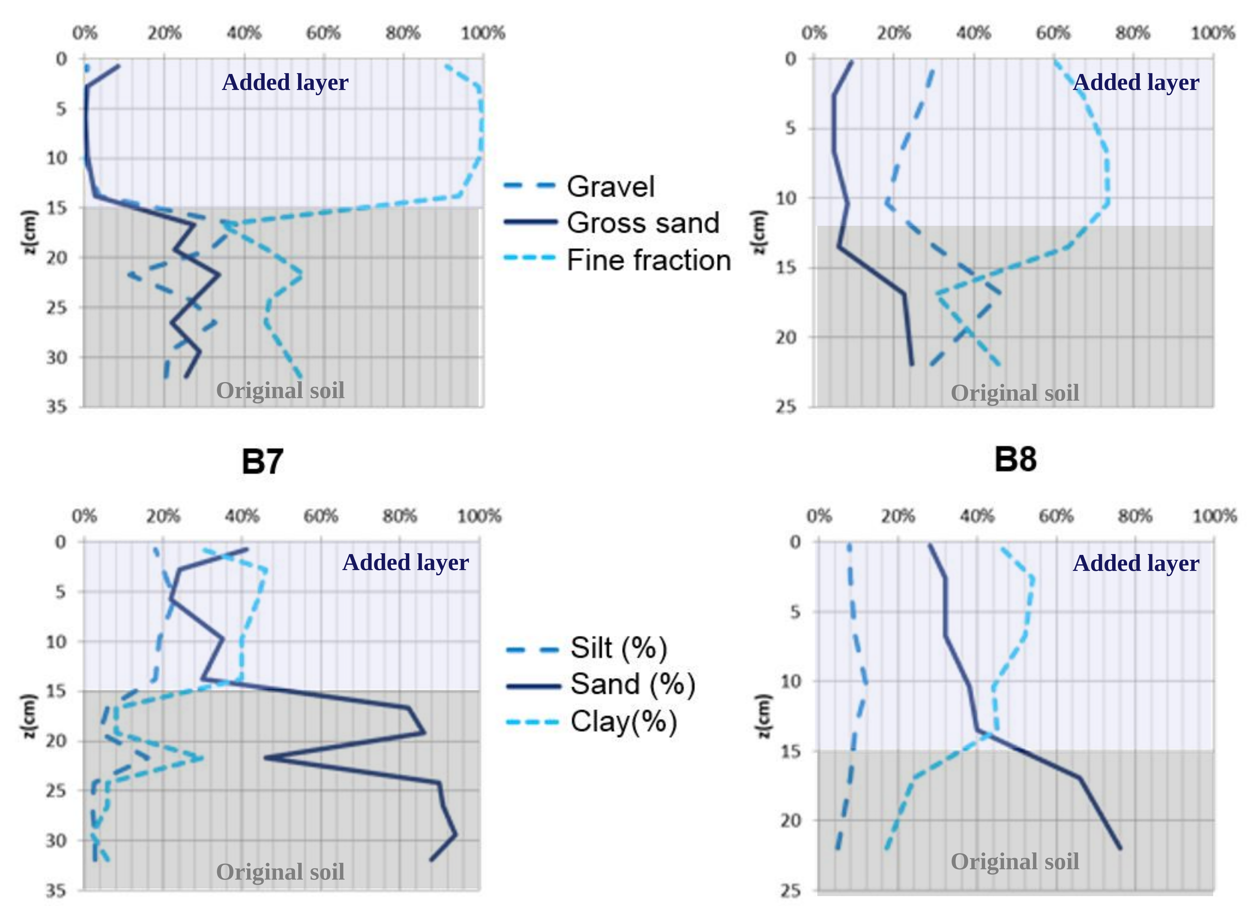

Figure 5. Granulometry and texture of soils

Moisture retention curve was determined directly from soil samples. The parameters were then adjusted using an optimization scheme based on minimizing the sum of squared errors (Figure 6).

Soil moisture retention curve

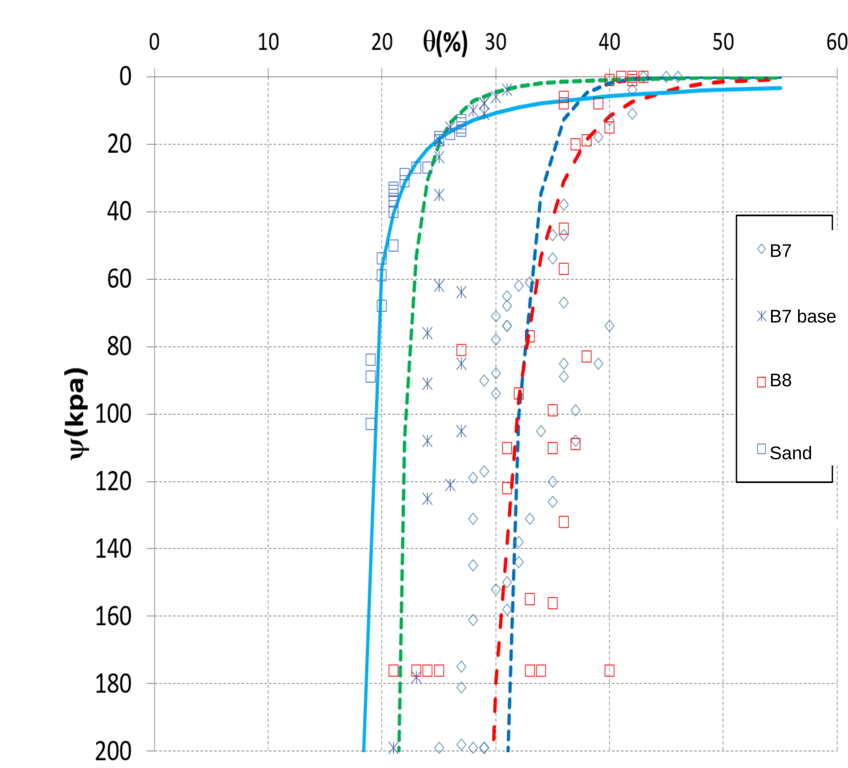

Figure 6. Measured permeability was k_s=2.9 x10^{-6} cm/s for soil B7 and k_s=6 x10^{-5} cm/s for soil B8.

Estimation of water movement using Hydrus program

Figure 7 shows the evolution in two probes located 5 cm deep one in the layer of added soil and another in the original soil.

In general, the model predicts well the behavior of moisture under the studied conditions.

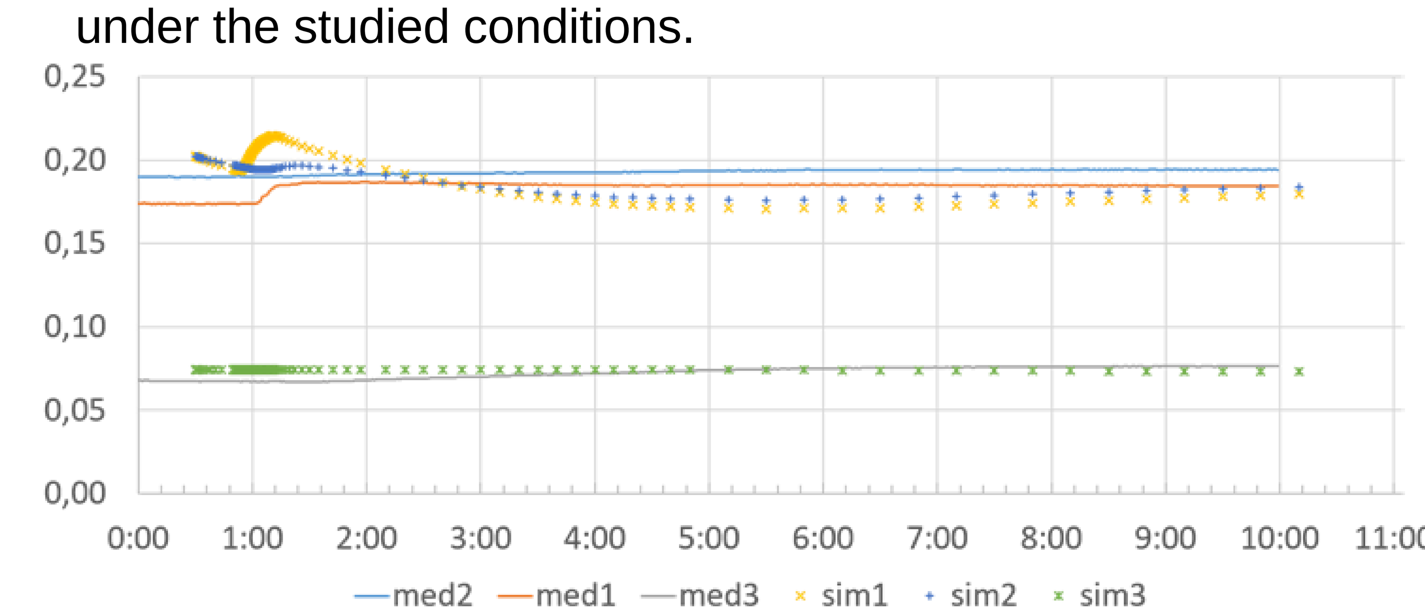

Figure 7. Evolution of measured (med) and simulated (sim) soil moisture for a typical day in February. Probes located 5 cm under the added layer (1, 2) and in the original soil (3). Soil B7

CONCLUSIONS

- A procedure has been defined for collecting and processing moisture data in stratified soils.
- The soil curve has been adjusted experimentally for each material and the information has been placed in the Hydrus model.
- The Hydrus model has been used to reproduce the behavioral conditions of a stratified soil and it has been possible to verify that the predictions are appropriate to what has been observed.

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