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Laboratory lysimeters and proximal sensing data for optimizing irrigation water needs

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The increase of irrigation efficiency and crop productivity in agriculture is nowadays a general requirement at national and international level to mitigate planet food security problems due to: the freshwater supply variability and scarcity enhanced by climate change (FAO, 2018), the increasing water demand due to population growth and also due to using ancient and sometimes empirical agricultural techniques.

To test the effectiveness of these irrigation strategies, on-field surveys alone are not enough. In the laboratory environment, a higher degree of insight is accessible, with a number of measurements that would be difficult on site.

In this work, we have tested the water dynamics related to the particular irrigation strategy developed in the SIM project (Smart Irrigation from soil moisture forecast using satellite and hydro-meteorological Modelling). The basic principle behind the strategy is that the soil moisture in the root-zone should be kept between the plant stress threshold and reducing deep percolation at all times. In that way, the irrigation amount is always enough so that the crop does not suffer water stress, and any water loss is avoided. As a comparison, two more common irrigation strategies have been tested in the same conditions: potential and deficit irrigation.

The laboratory set-up involves a wide range of instruments and devices: a lysimeter, a high-resolution (2g tolerance) scale, a thermal camera, a spectrometer, an infrared and an ultraviolet lamp, a radiometer and a leaf porometer. To increase the accuracy of the measurements, instead of working directly on the lysimeter, the crops have been cultivated in separate boxes, placed directly above the lysimeter. Three boxes have been managed according to each irrigation strategy. As a reference, one box has been kept with bare soil throughout the whole testing period, one has been filled with water and, finally, dense grass has been cultivated in another, totalling 12 boxes. The subdivision in boxes allows weighing each separately, guaranteeing higher accuracy.

The laboratory routine consisted of daily measurements of the weight of the boxes, together with measurements of temperature and leaf irradiance spectra. The evapotranspiration and percolation from each box are derived from the weight difference, and the water mass balance is closed for every box. At the end of the experimental set-up, the productivity for each irrigation strategy has been computed by measuring the final crop yield of each box.

Positive results, in terms of crop health and water savings, have been obtained with the SIM strategy.