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Assessing the performance of surface and subsurface drip systems on irrigation water use efficiency of citrus orchards in Spain

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In Mediterranean countries, water scarcity represents a real environmental concern at present and, according to the current climate change models predictions, the problem will be amplified in the future. In order to deal with this issue, application of strategies aimed to optimize the water resources in agriculture and to increase water use efficiency have become essential. On the one hand, it is important the election of the appropriate irrigation system for each particular case. On the other hand, identify the best management options for that specific irrigation system is crucial to optimize the available water resources without affecting yield. When using water saving strategies, however, it is a must to monitor the soil and/or crop water status in order to know the level of stress reached by the plants and to avoid levels that could lead to detrimental effects on yield. Stem water potential, ψ_{stem}, expressing the instantaneous condition of crop water stress, is considered a robust indicator of crop water status.

The main objective of this study was to assess the performance of a surface (DI) and subsurface (SDI) drip irrigation system in a citrus orchard with 7 (DI_7, SDI_7) or 14 emitters (DI_{14}, SDI_{14}) per plant, in terms of irrigation water use efficiency (IWUE) and possible amount of water saving.

The experiment was carried out in 2014 and 2015 in Alberique, Spain, (39°7'31" N, 0°33'17" W), in a commercial orchard (*Citrus clementina*, Hort. ex Tan. 'Arrufatina') in which four different treatments with three replications (12 sub-plots) were prepared according to a complete randomized block design.

Irrigation doses and timing were scheduled based on the estimated maximum crop evapotranspiration corrected according to measurements of ψ_{stem} and soil water content, and weather forecasts. In order to limit the maximum crop water stress, the thresholds of ψ_{stem} were assumed in the range between -0.8 and -1.0 MPa from January to June and between -1.0 and -1.2 MPa in the remaining period of the year.

In each sub-plot, soil water contents at different depths were monitored with a Frequency Domain Reflectometry probe (EnviroScan, Sentek, Stepney, Australia.), whereas ψ_{stem} values were acquired approximately weekly, with a Scholander chamber (Model 600 Pressure Chamber Instrument), on leaves wrapped in bags at least one hour before measurements. At the end of each season, the number of fruit per plant, the average fruit weight, the total yield and their corresponding variability were determined for each treatment.

The results showed that within both DI and SDI, treatments with the double number of emitters per plant had the highest yield, number of fruit, fruit weight and IWUE, although with no statistically significant differences. IWUE associated to DI and SDI was, on average for the two years, 6.5 and 7.4 kg/m^3, respectively. The best management option was achieved with the SDI_{14}, to which corresponded the minimum seasonal irrigation volumes, with water savings compared to DI_7 of about 23% and 28% in 2014 and 2015, respectively.