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Editorial

Water Management in Woody Crops: Challenges and Opportunities

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1. Introduction

Water is an essential resource for agriculture, accounting for 40–60% of total water consumption in Europe, mostly used for irrigation [1]. Climate and environmental changes put pressure on the use of water for irrigation, which must reduce water losses and wastages while improving the productivity of irrigated crops [2,3]. Water use optimization is essential for the long-term sustainability of agroecosystems, especially in arid and semi-arid regions, and under the current climate change scenarios (higher air temperatures, more severe drought, and heat waves), since crop yield, quality, and economic viability largely depend on water availability [1,4]. In the case of woody crops, it is a serious concern due to the large extension of these crops in different climatic conditions, the high inputs required for growing them, and the higher water losses due to soil evaporation (i.e., higher bare-soil proportion) in comparison to homogeneous crops. These limitations have driven the research of new strategies for coping with water scarcity, as the development of more efficient irrigation strategies (e.g., subsurface irrigation or regulated deficit irrigation) and sustainable soil management practices (e.g., plastic or vegetation mulching).

The aim of this Special Issue is to provide an overview of recent advances in several aspects related to water management in woody crops (i.e., fruit orchards, olive groves, vineyards, citrus, berries, forest stands, shrubs, etc.).

2. Overview of This Special Issue

This issue contains four research articles and one review that focus on several aspects of the management of water in woody crops. The range of cultivated species includes almond, grapevine, lemon, and persimmon. The main aspect addressed by these works is the evaluation of deficit irrigation strategies, but they also focus on crop evapotranspiration estimation and irrigation system design. All the published works come from Spain, so they serve as a summary of the most employed current methodologies for improving the efficiency of water management in these agroecosystems in this country. Undoubtedly, there are many more issues that could fit under the broad scope of this Special Issue, but the articles gathered already cover a sizeable range of subjects, from deficit irrigation strategies to crop modelling.

The efficient use of deficit irrigation strategies is the subject of two articles within this Special Issue. First, Gutiérrez-Gordillo et al. [5] tested two sustained deficit irrigation (SDI) regimes, varying the dose of water applied, against a full irrigation control in three almond cultivars grown in South Spain. They observed significant differences in the response of these cultivars, detecting an increase in the contents of sugars and fatty acids in the almonds from the SDI treatments, without relevant yield losses. These authors found highly significant correlations between leaf water potential (an indicator of tree water status) and fumaric acid, sugars, and fatty acids in the almonds [5]. This work opens the way to defining irrigation protocols adapted to specific almond cultivars and that account for both production and the nutritional composition of almonds. Second, Temnani et al. [6] were interested in implementing a sustainable irrigation protocol, according to the available water for the farmer, for table grapes in South East Spain. To achieve this objective, the authors established a three-year experiment in which they compared four treatments: a full irrigation control, two deficit irrigation strategies (regulated deficit irrigation and partial root drying), and the criteria followed by the farmer. The authors quantified the water use efficiency (WUE) of each treatment and observed WUE increased by 50% under the deficit irrigation treatments when compared to the control, reaching up to 81% during the third year of experimentation. The main outputs from this work are the definition of weekly irrigation protocols for a wide range of water availabilities (4000 to 7000 m^3 ha^{-1}) and the development of a model for predicting applied water using the day of the year and the daily maximum temperature as inputs [6].

In addition to deficit irrigation, Parra et al. [7] worked on the agronomic design of the irrigation system in young lemon and persimmon trees in South East Spain. They compared several irrigation designs varying the number of emitters and pipelines in the orchard, while maintaining the water dose applied. Moreover, in the case of lemon trees, these authors combined the irrigation design with two irrigation regimes (full irrigation versus SDI). Their results showed that the number of emitters and/or drip lines did not affect tree performance in the case of persimmon. However, the number of emitters per tree increased lemon fruit weight in the first year of experimentation. Additionally, in lemon, they observed differences during the third year of the experiment between full irrigation and SDI treatments. Specifically, these authors found that full irrigation increased trunk growth and average fruit weight, while it reduced the number of fruits per tree without affecting the total yield [7]. These authors concluded that for a given irrigation dose, frequency, and soil conditions, increasing the number of emitters or the wetted volume of soil only had slight positive effects on tree performance [7].

Sánchez et al. [8] monitored the crop evapotranspiration (ET_c) of a young almond orchard in South East Spain over three years using a simplified two-source energy balance model. They compared the outputs from the model with ground measurements performed with a flux tower. The uncertainties of the model outputs were relatively low, and the authors provided crop coefficients for this specific scenario of a young almond orchard, rarely available in the literature. Furthermore, these authors extracted relationships between the ET_c estimated by the model and the vegetation fraction cover and remote-sensing derived vegetation indices. This pioneering work leads to the possibility of predicting the water use of a given almond orchard, despite its age, by monitoring its biophysical properties [8].

Finally, the Special Issue contains a comprehensive review about the optimization of water management in vineyards for wine production [9]. This article compiles and summarizes results from more than 200 research papers and has two main novelties with respect to similar reviews. First, it points out the interactions between grapevine water status and biotic stressors, highlighting the need for addressing these relationships in the future. Second, the authors drive the attention to the use of novel technologies for optimizing irrigation in these agroecosystems. In the end, perspectives for future research are provided, including the performance of multifactorial studies accounting for the interrelations between water availability and other stressors, the development of cost-effective and easy-to-use tools for determining vine water status, and the study of less-known cultivars under different soil and climate conditions [9].

3. Conclusions

Clearly, the five articles composing this Special Issue only began to scratch the surface of a very broad area of research (as noted by the absence of articles devoted to disruptive technologies for automating irrigation, or the lack of articles dealing with relevant species such as olive trees). This area will undoubtedly become the focus of increasing attention as time goes by and the effects of climate change on these agroecosystems become more pronounced. In this context, it is our hope that this Special Issue will contribute in some measure to fostering a healthy debate on whither the research should be heading in years to come.

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References

1. European Environment Agency. *Water Resources across Europe—Confronting Water Stress: And Updated Assessment*; EEA Report 12/2021; Publications Office of the European Union: Luxembourg, 2022; 132p. [CrossRef]
2. Fereres, E.; Soriano, M.A. Deficit irrigation for reducing agricultural water use. *J. Exp. Bot.* **2007**, *58*, 147–159. [CrossRef] [PubMed]
3. Pereira, L.S.; Paredes, P.; Melton, F.; Johnson, L.; Mota, M.; Wang, T. Prediction of crop coefficients from fraction of ground cover and height: Practical application to vegetable, field and fruit crops with focus on parameterization. *Agric. Water Manag.* **2021**, *252*, 106663. [CrossRef]
4. Masia, S.; Trabucco, A.; Spano, D.; Snyder, R.L.; Sušnik, J.; Marras, S. A modelling platform for climate change impact on local and regional crop water requirements. *Agric. Water Manag.* **2021**, *255*, 107005. [CrossRef]
5. Gutiérrez-Gordillo, S.; Lipan, L.; Durán Zuazo, V.H.; Sendra, E.; Hernández, F.; Hernández-Zazueta, M.S.; Carbonell-Barrachina, A.A.; García-Tejero, I.F. Deficit irrigation as a suitable strategy to enhance the nutritional composition of HydroSOS almonds. *Water* **2020**, *12*, 3336. [CrossRef]
6. Temnani, A.; Conesa, M.R.; Ruiz, M.; López, J.A.; Berríos, P.; Pérez-Pastor, A. Irrigation protocols in different water availability scenarios for 'Crimson Seedless' table grapes under Mediterranean semi-arid conditions. *Water* **2021**, *13*, 22. [CrossRef]
7. Parra, M.; Hortelano, D.; García-Sánchez, F.; Intrigliolo, D.S.; Rubio-Asensio, J.S. Effects of drip irrigation design on a lemon and a young persimmon orchard in semi-arid conditions. *Water* **2021**, *13*, 1795. [CrossRef]
8. Sánchez, J.M.; Simón, L.; González-Piqueras, J.; Montoya, F.; López-Urrea, R. Monitoring crop evapotranspiration and transpiration/evaporation partitioning in a drip-irrigated young almond orchard applying a two-source surface energy balance model. *Water* **2021**, *13*, 2073. [CrossRef]
9. Mirás-Avalos, J.M.; Araujo, E.S. Optimization of vineyard water management: Challenges, strategies, and perspectives. *Water* **2021**, *13*, 746. [CrossRef]