ZEN-IRRIWARE, PRECISION IRRIGATION SOFTWARE - APPLICATION ON OLIVE ORCHARDS

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SUMMARY: Precision irrigation is a system that supports end-users' decisions with regard to how much to irrigate and when and is uniformly applied across the field minimizing environmental risks. In the present study precision irrigation was applied for two years in olive orchards of three cooperatives in Crete, Greece using Zen-Irriware software for the calculation of water needs of olive trees in real time. The olive orchards were irrigated empirically resulting in great fluctuations in the total amount of applied water per season, ranging from 54 to 825 mm. Moreover, although the majority of the farmers used localized irrigation system (drippers or micro sprinklers), the interval between irrigations was long (10-20 days) and the irrigation dose quite high (20-55 mm). The Zen-Irriware utilizes weather forecast in order to adjust irrigation, reduce crop risks (plant damage) and improve yield (quantity and quality) using GSM controller and sensor communication. Using weather forecasts, the available on-line data from existing meteorological stations and tailor-made algorithms, the Zen-Irriware calculates crops irrigation requirements. The algorithm is developed according to FAO proposed methods, taking into account crop characteristics (age, growth stage, etc), soil type, irrigation system, water quality and availability, as well as the last irrigation details. Then, the system automatically informs the farmer via email or SMS when and how much water to apply for each parcel and creates corresponding messages in the user's account. The results showed that the application of precision irrigation in olive orchards in a region without water availability problems resulted in significant water saving (30-160%) compared to the applied practice (empirical irrigation) and optimization of the moisture in the soil.

KEYWORDS: Water requirements; irrigation scheduling; water saving; olive

1. INTRODUCTION

Water resources worldwide are currently under pressure due to the rapid increase of world population, the extension of irrigated land, the industrial development and the climate change. Water is essential not only for agriculture, industry and economic growth, but also it is the most important component of the environment, with significant impact on health and nature conservation. Because of the increasing problems due to fresh water scarcity, man has begun to realize that he can no longer follow a "use and discard" methodology either with water resources or any other natural resource. As a result, the need for a consistent policy of rational management of water resources has become a necessity.

Agriculture currently uses about 70% of the total fresh water withdraw globally, mainly for irrigation. The last 50 years the irrigated lands globally almost doubled reaching 310 Mha (Siebert et al., 2015; ICID, 2018). More than 40% of the world's food comes from the 20% of the cropland that is irrigated. On the other hand 8-15% of fresh water supplies will be diverted from agriculture to meet the increased demand of domestic use and industry. Furthermore the efficiency of irrigation is very low, since only 65% of the water is used by the crop. The farmers mainly irrigate empirically and tend to "play safe", increasing irrigation water amount, especially when water price is low. As a result about 25 % of water applied is lost, while at the same time tensions and conflicts with other sectors (urban, tourism) arise. To overcome water shortage for agriculture is essential to increase the water use efficiency and to use marginal waters (reclaimed, saline, drainage) for irrigation.

Irrigation scheduling tools (software) can play an important role in assisting farmers to increase water efficiency, minimizing environmental risks and contributing to the sustainability of agricultural sector (Fereres et al., 2011, Malamos et al., 2016, González Perea et al., 2017). A new frontier for optimizing the use of irrigation water is 'Precision Irrigation' (PI), a practice that can be applied to any type of irrigation technique. PI is a system that supports end users' decisions with regard to how much to irrigate and when and is uniformly applied across the field. The present work describes the Zen-Irriware software, used for precision irrigation of horticultural crops with specific application in olive orchards.

2. MATERIALS AND METHODS

2.1 Data used. Zen-Irriware software is supported by meteorological stations (M/S) and soil moisture sensors integrated into a wireless network which provide data to a real-time decision support system. The design of the sensors network considers also all factors affecting their proper function. For the accurate calculation of irrigation requirements of the crop, it uses the available meteorological data of the area, the weather forecast, the soil characteristics, the elements of the crop, the availability and quality of water and the method of irrigation. It cooperates with different types of M/S and receives real-time data in various formats. In addition, it uses data from different nearby M/S, if required. When for any reason the main M/S of the area does not work, the software automatically or manual, selects the alternative source of meteorological data for the calculations.

Water requirements estimation. Daily Evapotraspiration (ETc) of the crop is calculated by the formula ETc = Kc x ETo (Allen et al., 1998), where ETo is Reference Evapotraspiration and Kc is the crop factor, that varies according the crop and the growth stage (Doorenbos and Pruitt, 1992). Irrigation requirements are calculated as the difference between the evapotranspiration of the crop and the effective rainfall (0.8 of the total), while the irrigation dose is determined according to the soil type. In case of limited water availability (dry year), water requirements are calculated only for the critical growth stages (application of deficit irrigation). The data are stored in a database, so that upon request the system combines all the relative information in order to calculate the optimal irrigation dose. Zen-Irriware layout is given in Figure 1.

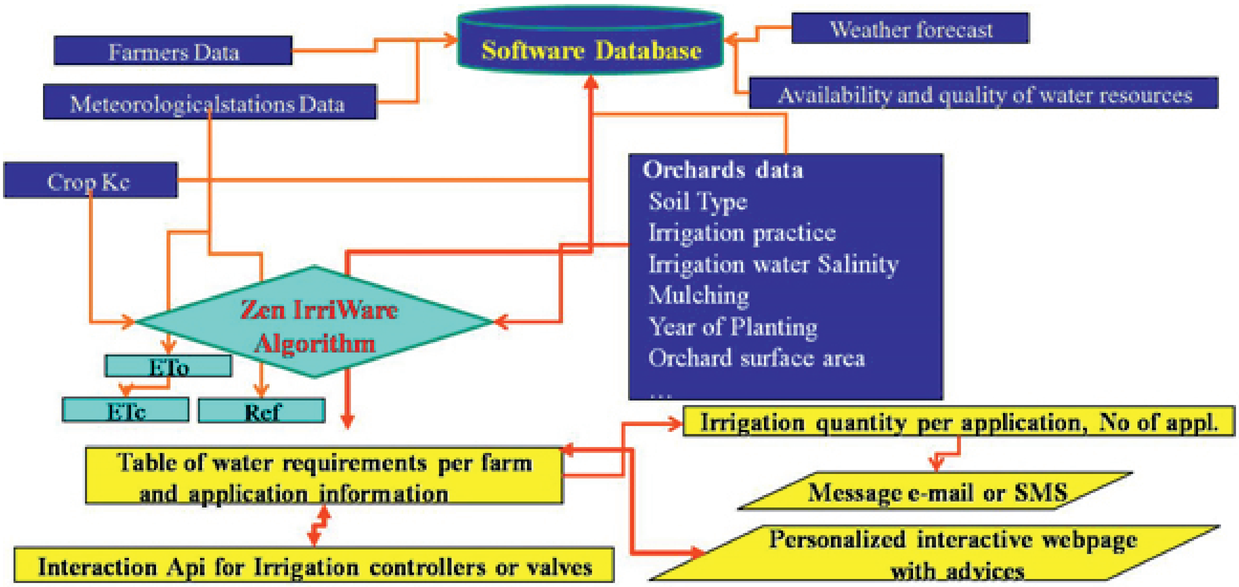

Figure 1. Zen-Irriware layout

2.2 Database structure. Important elements of Zen-Irriware database structure are the following data categories, created in a simple and functional way:

- Meteorological data from the weather station stored and used for ETc estimation.

- Farmers data including individual entries for each farmer, team of farmers or a cooperative.

- Orchard data including individual entries for orchards within each entry of farmers database, which contain all information required for the calculation of irrigation requirements like soil characteristics, farming techniques, characteristics of culture (table olives, oil production, age of the trees, etc), the quality and availability of water and the system of irrigation.

2.2 Data management. All data are stored in a database and the system combines all the relevant information to calculate the optimal irrigation dose and time of irrigation. If the M/S has soil moisture sensors, the software can take this information into account when deciding when and how much to irrigate. Zen-Irriware works with weather forecasting models and takes this information into account when calculating irrigation needs or timing. In addition, it warns the farmer if extreme weather events (heat waves, frost) will take place to take protective measures.

The data is processed by the system and displayed in the form of irrigation application instructions via PC (e-mail) or SMS message (Figure 2). The application of water is done through the irrigation infrastructure (irrigation system, quantity control and recording, etc.). The farmer can communicate with the software, record the amount of irrigation water and have an interaction with the system. Furthermore, the software can interact with solenoid electrovalves to switch on-off the irrigation without farmer intervention.

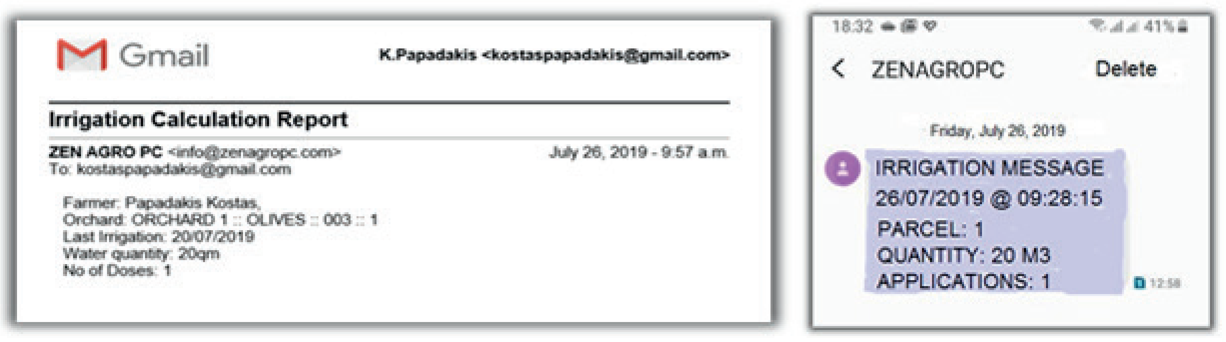

Figure 2. Irrigation messages sent to the farmer

RESULTS AND DISCUSSION

Precision irrigation based on the Zen-Irriware software has been successfully applied since 2018 in farmers groups (PO) in Crete, in large private olive groves with integrated and organic management and in other crops throughout Greece. In case that there is no private M/S to provide meteorological data, the system cooperate with the Weather Underground M/S network (https://www.wunderground.com/), which covers the whole country. Before the application of precision irrigation olive orchards were irrigated empirically resulting in under- or over-irrigation of the trees, waste of water and negative effects on crop yield and quality of olive oil. Especially in the olive groves in Crete, Greece the irrigation was done 1-3 times in the critical months (July-August or even September) with quantities of 15-130 mm, while the total water requirements of olive orchards in the areas range between 220 - 320 mm per year (Chartzoulakis and Bertaki, 2006).

The amount of irrigation water applied to the olive groves of each group of producers with the Zen-Irriware system ranged from 240-290 mm per year (Figure 3 A & B). In the Producers Group where there is no problem with water availability, the results show that water saving instead economy is significant, up to 270% in relation to the applied empirical irrigation practice (Figure 3A). In the Producers Group, which for various reasons olives was mostly under-irrigated, the application of Zen-Irriware irrigation consulting helped to rationalize irrigation and optimize soil moisture, as no extreme water deficit conditions were observed (Figure 3B).

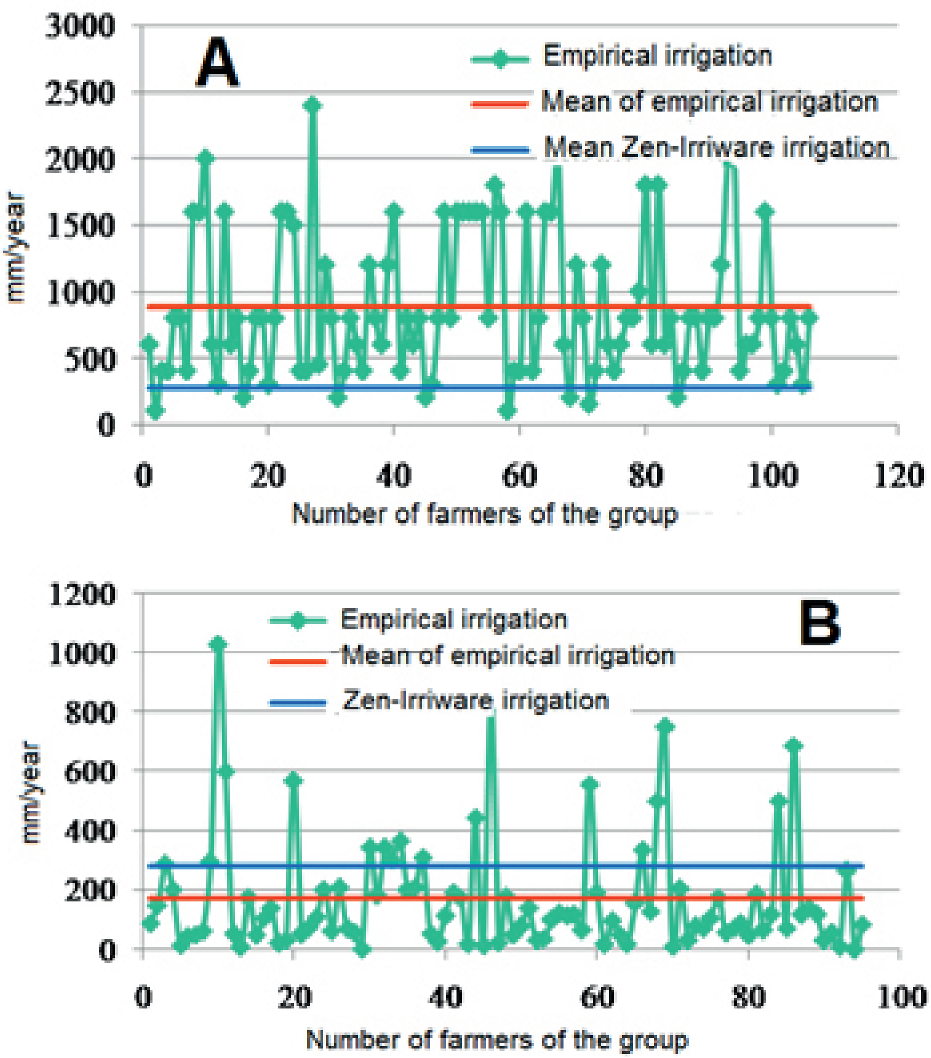

Figure 3. Optimization of olive irrigation using Zen-Irriware

CONCLUSIONS

ZEN-IRRIWARE is a simple and user-friendly way to apply precision irrigation in olive orchards. It takes into account current weather data, weather forecasts, crop and soil parameters, water quality and availability and irrigation system. Furthermore, it cooperates with wUnderground meteo station network or private M/S and irrigation advices (when to irrigate and how much water to apply) are given to farmers who are not familiar with new technologies with a message through a simple cell phone or directly to solenoid electrovalve. In addition, the farmer can interact with the software by recording irrigation application contributing in significant water saving.

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