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Use of precision irrigation for water efficient management in a processing tomato farm

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Introduction

Intensification of agriculture, population growth and climate change have put pressure on available water resources. Therefore, there is an urgent need to adopt efficient irrigation systems that adjust the real water needs of crops, mitigate climate change and improve the profitability of farms. Irri_DesK is a digitisation tool that enables precision automatic irrigation by combining different crop monitoring and simulation technologies to optimise water use in agriculture, especially for farmers with irrigation limitations. Daily in Irri_DesK, a daily closed loop is produced to control irrigation using an algorithm that combines data from soil sensors, meteorological data, satellite remote sensing and simulations (Casadesús et al., 2012).

The aim of this work is to test the technical feasibility and evaluate the productive response in a commercial industrial tomato plot located in Vegas Bajas del Guadiana using the Irri_Desk tool to implement an automated drip irrigation system. In addition, it was evaluated how Irri_Desk achieves profitable productions with a water consumption limit lower than 5500 m³/ha.

Material and Methods

The work was carried out within the DIGISPAC project, in collaboration with the companies UNILEVER and GRUPO CONESA through their company AGRAZ in a commercial plot of industrial tomato of 15 hectares belonging to the company Explotaciones Aldea del Conde, S. L. (Alconsa S.L.), located on the Aldea del Conde farm in the municipality of Talavera la Real, Badajoz, Spain (latitude 38°84'65.64 "N, longitude 6°72'59.18 "W, datum WGS84).

The crop planted was industrial tomato (Lycopersicum esculentum Mill) variety UG16112, transplanted from 3-10 April 2023. The planting density was 29,000 (plants / ha) in a double row with plants placed in three rows with 46 cm between continuous plants.

Before transplanting the crop, a spatial characterisation of the plot was carried out using historical maps of the Normalised Vegetation Index (NDVI) and massive measurement of the apparent soil conductivity (ECa) with the Dualem-1S sensor made by the company GREENFIELD.

Figura 1: Parcela de ensayo: a) Mapa Índice de Vegetación Normalizada, b) Mapa de conductividad eléctrica aparente del suelo, c) Zonas con diferente manejo del riego

The plot was divided into three differential drip irrigation management zones according to the following criteria:

Zone 1 (CICYTEX): Automatic irrigation management following the information provided by the Irri_Desk web platform. In this case, controlled deficit irrigation (CDI) strategies were applied in the ripening phase. This zone had an area of 5.12 ha.

Zone 2 (AGRAZ): Irrigation management traditionally carried out by the farmer. This zone had an area of 4.34 ha.

Zone 3 (GREENFIELD): Management according to the recommendations proposed by the company's technicians. This zone had an area of 4.30 ha.

Zone 2, at each control point was monitored as follows:

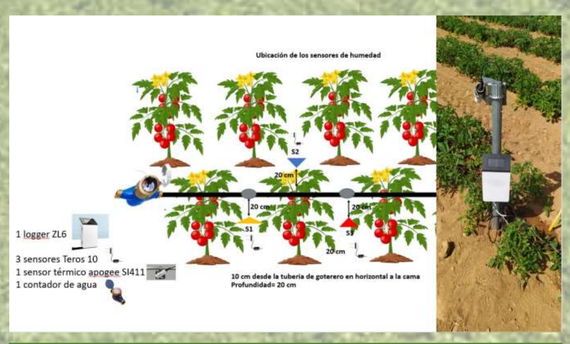

Figura 2: Esquema de la instalación de sensores en campo

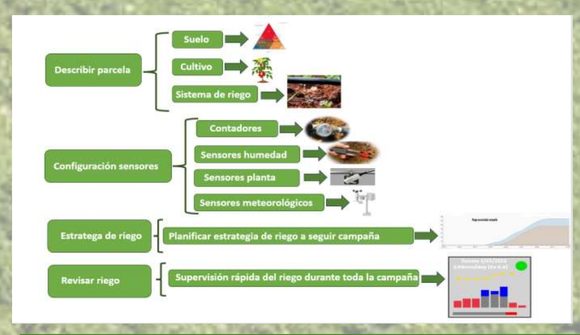

Figura 3: Diagrama de flujo de funcionamiento de Irri_DesK

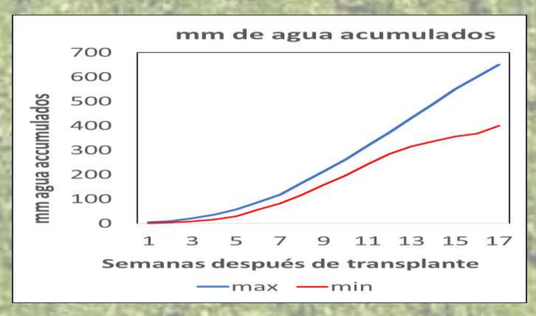

Figura 4: Valores de agua acumulada máximo y mínimo

The campaign plan entered in Irri_DesK was imposed by the farmer, who indicated that he normally applied about 550 mm during the whole irrigation campaign. Thus, a maximum limit of 650 m and a lower limit of 400 mm was introduced in Irri_DesK.

Results

Figure 5 shows the amount of water applied and the seasonal plan in the area managed by Irri_DesK. In industrial tomato cultivation there are the following crop phases: transplanting phase (Phase I), rapid growth phase (Phase II), fruit growth phase (Phase III) and ripening phase (Phase IV). It is observed that after transplanting (Phase I), Irri_DesK applies less water than that imposed in the seasonal plan. At the time of transplanting, the soil profile is filled with water up to the maximum depth that reaches the roots, so that Irri_DesK adjusts to the specific conditions of the plot and reduces the water applied in this phase. In the rapid growth phase (phase II) RDC cannot be applied as a water deficit in this period can lead to a high number of flower abortion. So, here the system follows the previously imposed seasonal plan. Then, in the fruit growth phase (phase III), RDC strategies cannot be applied either, as fruit fattening must be encouraged. Figure 3 shows how Irri_DesK is modulated and adjusted to the seasonal plan initially foreseen in the campaign so that the crop does not suffer water stress. In the ripening phase of the crop (IV), the green fruits start to turn red and this is a favourable period to apply RDC strategies. Irri_DesK adjusts at this stage of the crop by reducing the amount of water applied to the crop.

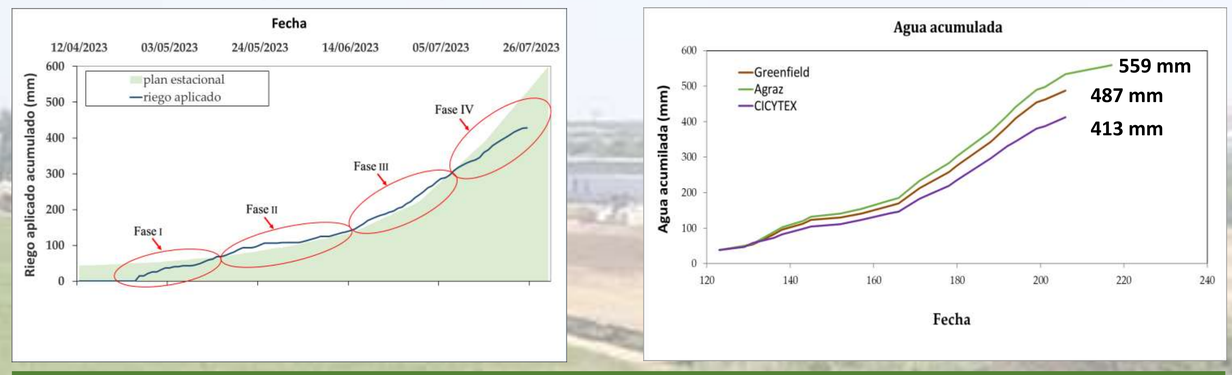

Figura 5: Agua acumulada aplicada en 2023 en la zona gestionada por Irri_DesK (línea azul). La zona sombreada de verde corresponde a la estrategia de riego a seguir (plan estacional) inicialmente introducida en Irri_DesK

Figure 6 shows the amount of water applied to each of the irrigation zones during the entire irrigation campaign in 2023. The amount of water applied in the area managed by Greenfield and Agraz was higher than the water applied in the area managed by CICYTEX. In the area managed by CICYTEX, 26% less water was applied than in the area managed by Agraz and 15% less water than in the area managed by Greenfield.

Figure 7 shows the commercial and total production in the different zones. It can be seen that there are no differences in terms of production in the area managed by CICYTEX and Agraz. The production obtained in the Greenfield area is approximately 106,000 kg/ha lower than in the other areas. In all the irrigation management zones, the average production is higher than the average for the area. Figure 8 shows the º Brix and Ph obtained in each of the zones during the 2023 campaign. In the area managed by Greenfield, the º Brix obtained were higher than in the rest of the areas, with the area managed by Agraz having the lowest º Brix. As for pH, there were no significant differences in the different zones.

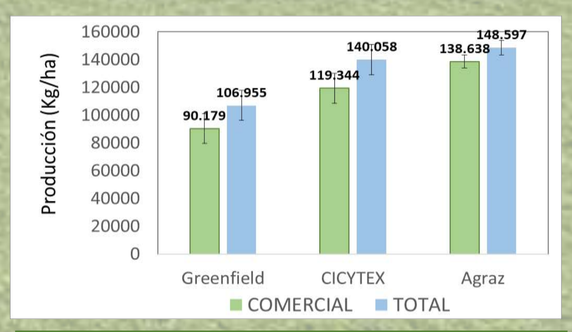

Figura 7: Producción (kg/ha) en cada zona de riego

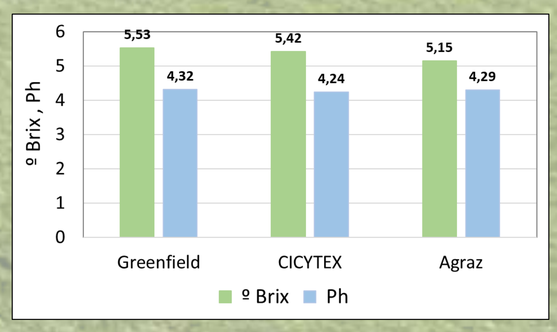

Figura 8: Parámetros de calidad en cada una de las zonas

Conclusions

In this study, a precision automatic irrigation system was tested in an industrial tomato crop with the Irri_DesK web platform (managed by CICYTEX), comparing it with the irrigation management carried out by a farmer and a technician from the precision agriculture company:

It is necessary to perform a spatial characterisation of the plot to identify the most suitable points where the sensors are to be installed.

Irri_Desk enabled automatic irrigation management based on the agronomic management selected by the farmer, adjusting the water doses according to the soil moisture conditions.

Irri_Desk used a lower volume of water than the farmer (around 26% on average) and lower than the Greenfield technician (around 15% on average), adapting in each area to the information provided by the sensors.

Irri_Desk makes it possible to maintain a good production with a water limit set as an initial target.

Irri_DesK can adjust irrigation scheduling according to the water content of the soil and improve water use efficiency.

Irri_DesK is able to improve the quality of industrial tomatoes and consequently the profitability of the crop.

References

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