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CICYTEX

IRTA RECERCA I TECNOLOGIA AGROALIMENTÀRIES

Use of IrriDesk automatic irrigation system to management deficit irrigation strategies in processing tomato

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Introduction

The water available for the cultivation of processing tomatoes in Extremadura in a regular season is set at 6000m³/ha. When water restrictions are set, farmers reduce the cultivation area and adjust it proportionally to the irrigation dose received. However, droughts are threatening to become more frequent, leading to increased competition for water, hence the need to raise awareness of the need for more efficient water consumption. In processing tomatoes, adopting deficit irrigation strategies effectively increases total soluble solids in fruit (Johnstone et al., 2005) and leads to significant water savings. However, these strategies are often difficult to implement by farmers because they depend on different factors (soil, crop development, phenological moment) that do each year and farmer are different its application. IrriDesk is a tool for precision irrigation that integrates different technologies: sensors, remote sensing and simulations (Casadesús et al., 2012).

OBJECTIVE: To evaluate the IrriDesk irrigation automation system as a tool to manage irrigation in industrial tomato crops using controlled deficit irrigation strategies to improve water use efficiency and establish guidelines to help the system manage water efficiently in drought situations.

Material and Methods

Experimental field

Location: CICYTEX experimental farm, in Guadajira

Variety: Processing tomato H1015

Transplanted 15 April 2023

Harvest 10 August 2023

Treatment:

T1: Deficit Irrigation in the maturation phase (RC)

T2: Irrigation according to crop requirements (LIS)

T3: Deficit Irrigation in the initial and maturation phase (RDC)

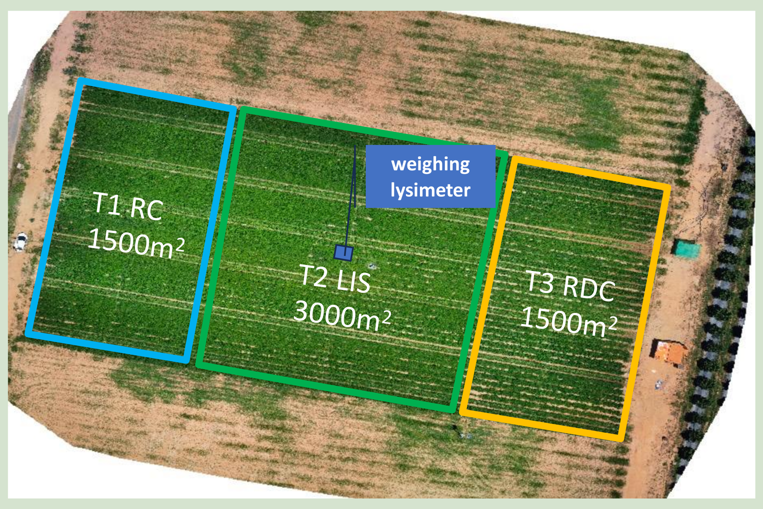

Figure 1. Study plot and established treatments: The area with blue box (T1), green box (T2) and yellow box (T3)

Control points

To study the spatial variability of the plot, a map of the apparent electrical conductivity of the soil (ECa) at 0-0.50 m depth. Three distinct zones were differentiated in the map: (I) Green, higher sand content and lower water retention capacity; (II) Yellow, intermediate soil texture and water retention capacity; and (III) Red, zone with a more clayey soil texture and higher water retention capacity. In treatments T2 and T3, three control points were selected to adjust the water schedule, with three soil moisture sensors (Teros 10) and Infrared sensor (Apogee) and in treatment T1, six points were chosen to monitor crop water status (Figure2). In all points water potential and Multispectral and termal image from drone were measure weekly.

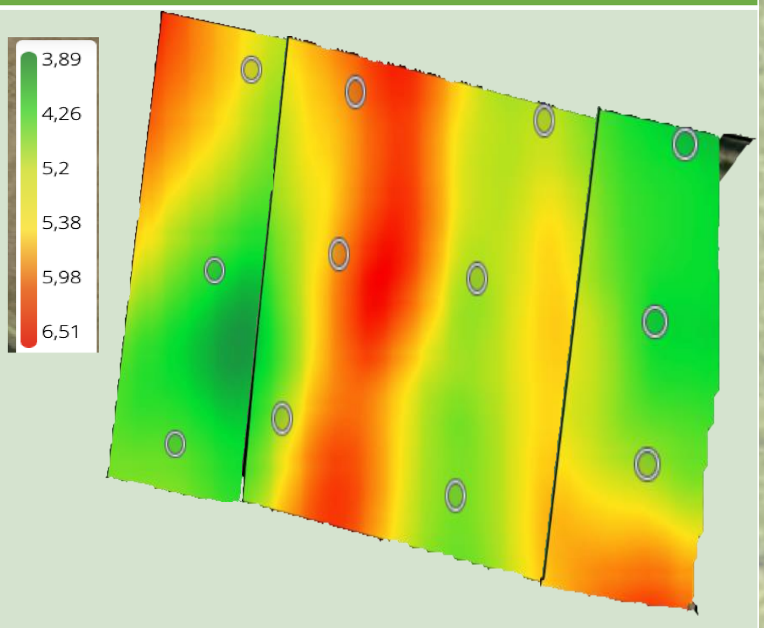

Figure 2. Map of apparent electrical conductivity of the soil (ECa, (mS/m)) at 0-0.5m depth.

Irrigation plan

In treatment T2, irrigation was programmed to cover the water needs of the crop throughout its cycle, based on the ETc of the previous day, obtained from a weighing lysimeter (2.67 m x 2.25 m x 1.5 m) in which the crop conditions were reproduced as in the rest of the trial. The T1(RC) treatment was carried out automatically with the IrriDesk web platform in which deficit irrigation was carried out during the ripening phase. Treatment T3 (RDC) was also carried out with IrriDesk but induced stress in the initial phase (until 20% of ground cover) and later in the ripening stage of the crop, coinciding with that carried out in treatment T1 (Figure 3).

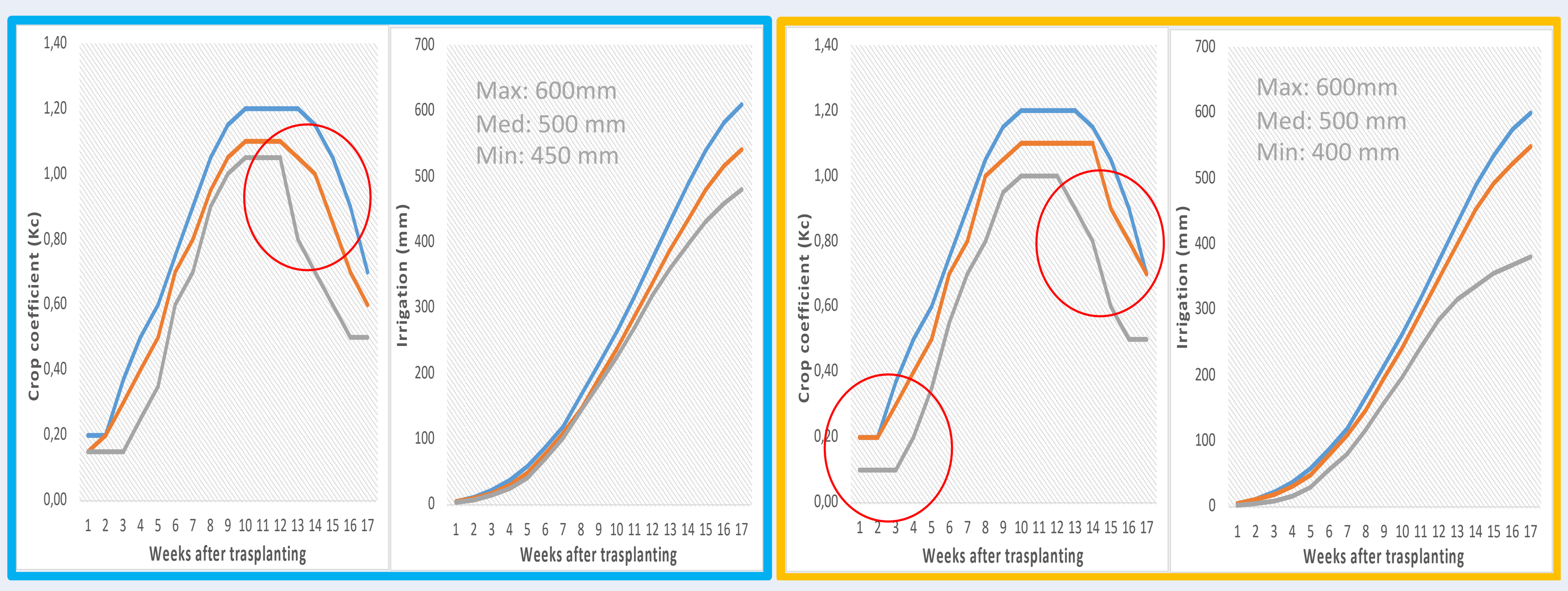

Figure.3. The Blue box corresponds to treatment T2, to which deficit irrigation was applied at the ripening stage. The yellow box corresponds to treatment T3, in which deficit irrigation was used at the initial and ripening stages of the crop.

Results

Evolution of accumulated water applied in the treatments

The Irridesk system allowed the maintenance of the accumulated applied water below the expected average throughout the irrigation campaign, thus reducing the quantities of water applied below the proposed maximum target (figure 4a). The total volume was lower in T2 and T3 than in T1, remaining below the pre-established limit of 500 mm (red line), indicating that the system responded satisfactorily to the pre-imposition established. In T1, 640 mm were applied, 32% higher than in T2 and 48% higher in the case of T3 (figure 4b).

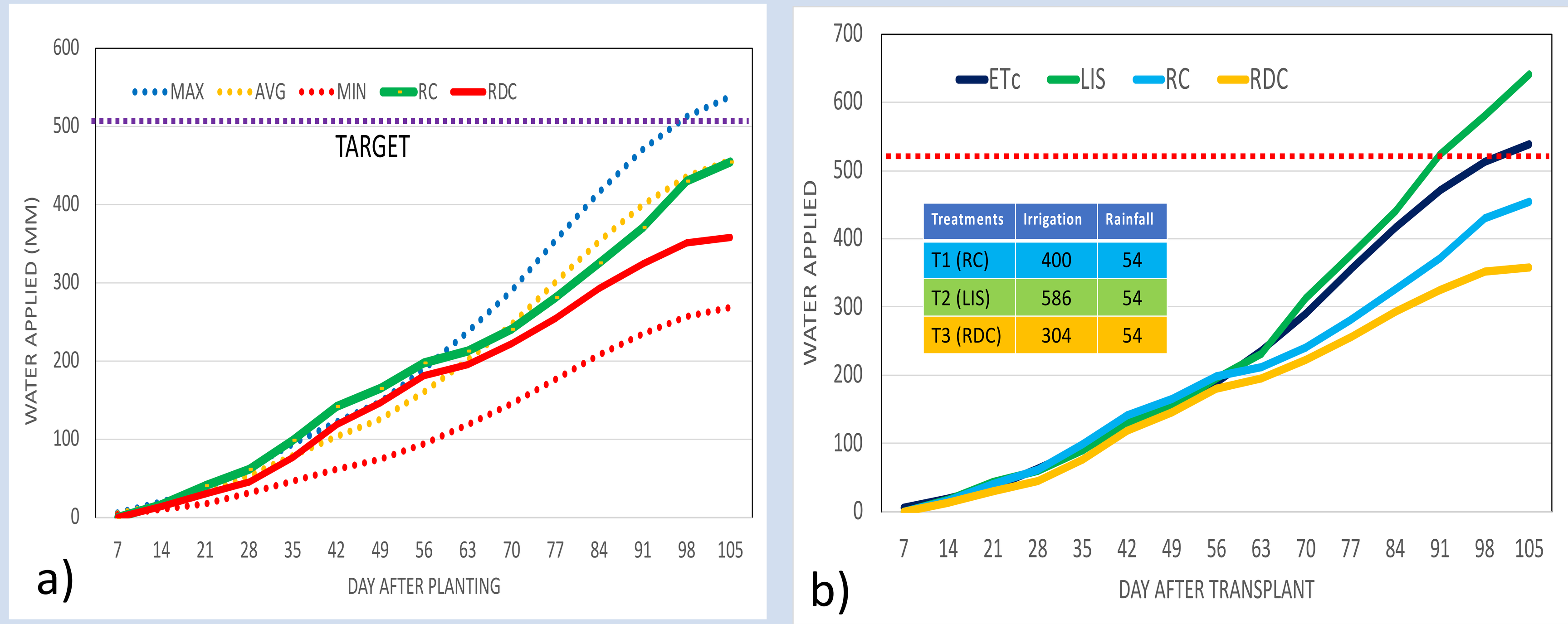

Figure 4. (a) Evolution of the water applied in each of the automatically irrigated treatments (RC and RDC) in relation to the maximum and minimum limits proposed in the campaign plan. (b) Water applied in the year 2023 to each irrigation treatment and rainfall.

Yield and Quality

The commercial yield in T2 was approximately 135 t/ha, higher than in treatments T1 and T3 (figure 5a); both maintained an average yield higher than the average for the area in recent years (80-85 T/ha). It was demonstrated that the deficit irrigation strategy applied in the initial phase of the crop in treatment T3 directly affects crop production. The Brix value increased considerably in the two less irrigated treatments between T1 and T3 (figur3 5b), with no differences. The increase in quality in T1 compensated for the differences in yield compared to the T2 treatment. Secondly, the volumes applied in treatment T2 would have required a 25% reduction in crop area to comply with the established endowments (5,000 m3/ha). However, the adjustment in the case of treatment T3 to the water allocations, which is almost 50% lower than T2, would allow a 25% increase in area. In the case of T1, the adjustment of the maximum allocation would allow for maintaining the same area with the established water volumes per area. From the combination of both factors, the increase in quality and maintenance or reduction of the surface area, depending on the allocation, were obtained as the value of opportunity in using water for each treatment. The data shows that treatment T1 has a better theoretical income per opportunity than T2 (Figure 5c).

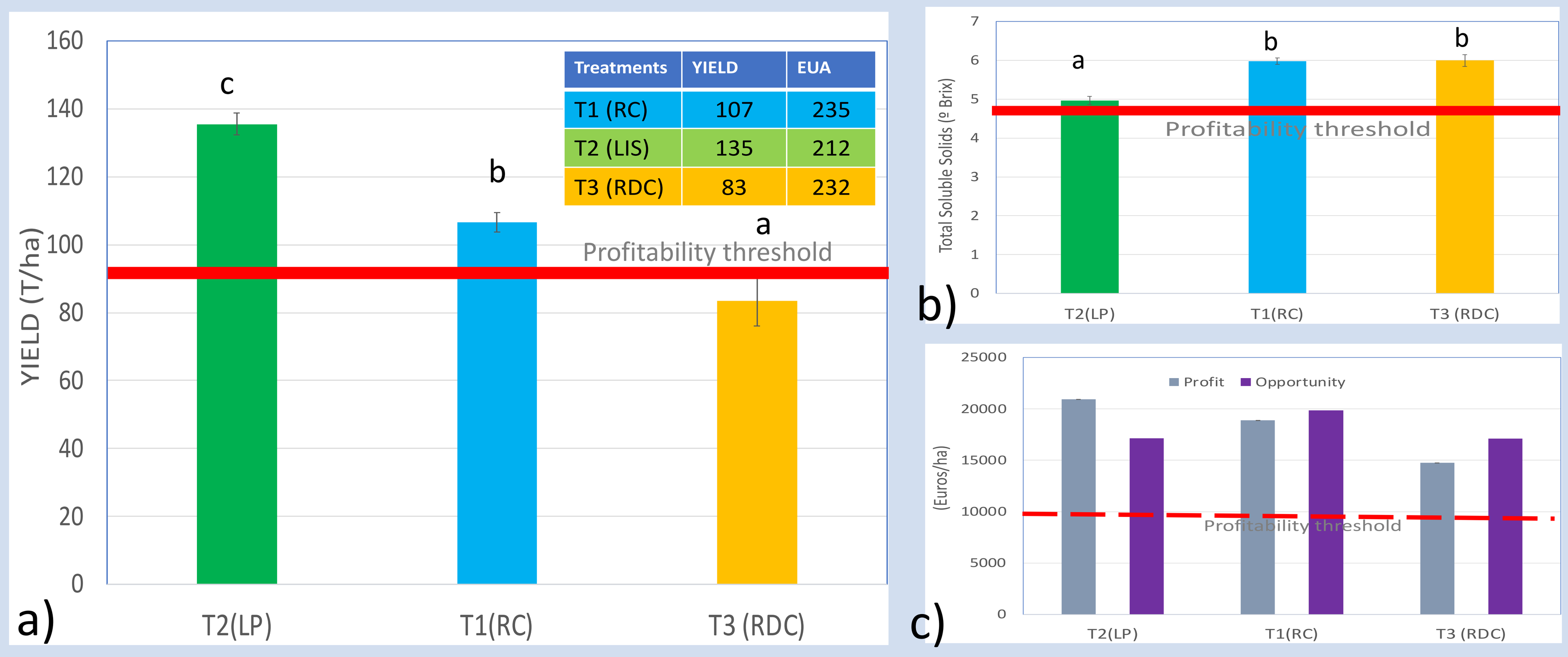

Figure 5. (a) Yieldand (b) Quality parameter (°Brix) measured in the different treatments and (c) Income and water use opportunity (€/ha) for each treatment The red line indicates the threshold value to yield average in the zone, minimum Brix required and profitability minimum value in each case. Different letters indicates significant differences between treatments p<0.05 according to the Tukey test.

Conclusions

- Irridesk automatic irrigation system permits maintaining a good production with a water maximum limit set as an initial target.
- IrriDesk automatic irrigation system can adjust the irrigation scheduling in the function of soil water content and improve efficient water use.
- The application of deficit irrigation during the initial cultivation phase has reduced crop development, causing a significant decrease in production.
- Identifying the most crucial phenological moments is necessary to avoid stressful situations at sensitive times. In this sense, using crop development monitoring systems with NDVI will facilitate a better adjustment of crop development to the irrigation seasonal plan.

References

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Acknowledgements

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