Automated irrigation of soil-grown greenhouse tomato crops in a Mediterranean area

Sub-project INIA RTA 2013-00045-C04-03

Automated irrigation of soil-grown greenhouse vegetable crops

National project INIA RTA2013-00045

Integrating soil water sensors on a seasonal strategy for automated re-scheduling of drip irrigation

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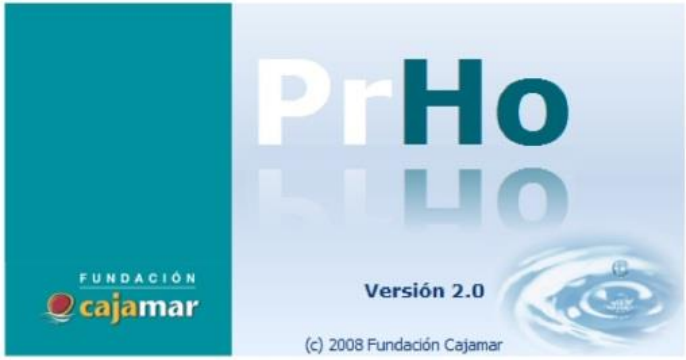
Automated irrigation of soil-grown greenhouse tomato crops

❑ The automated irrigation is driven by a software programme (IRRIX) developed by the department of "Efficient use of water", IRTA-Lleida (Jaume Casadesus).

How IRRIX work?

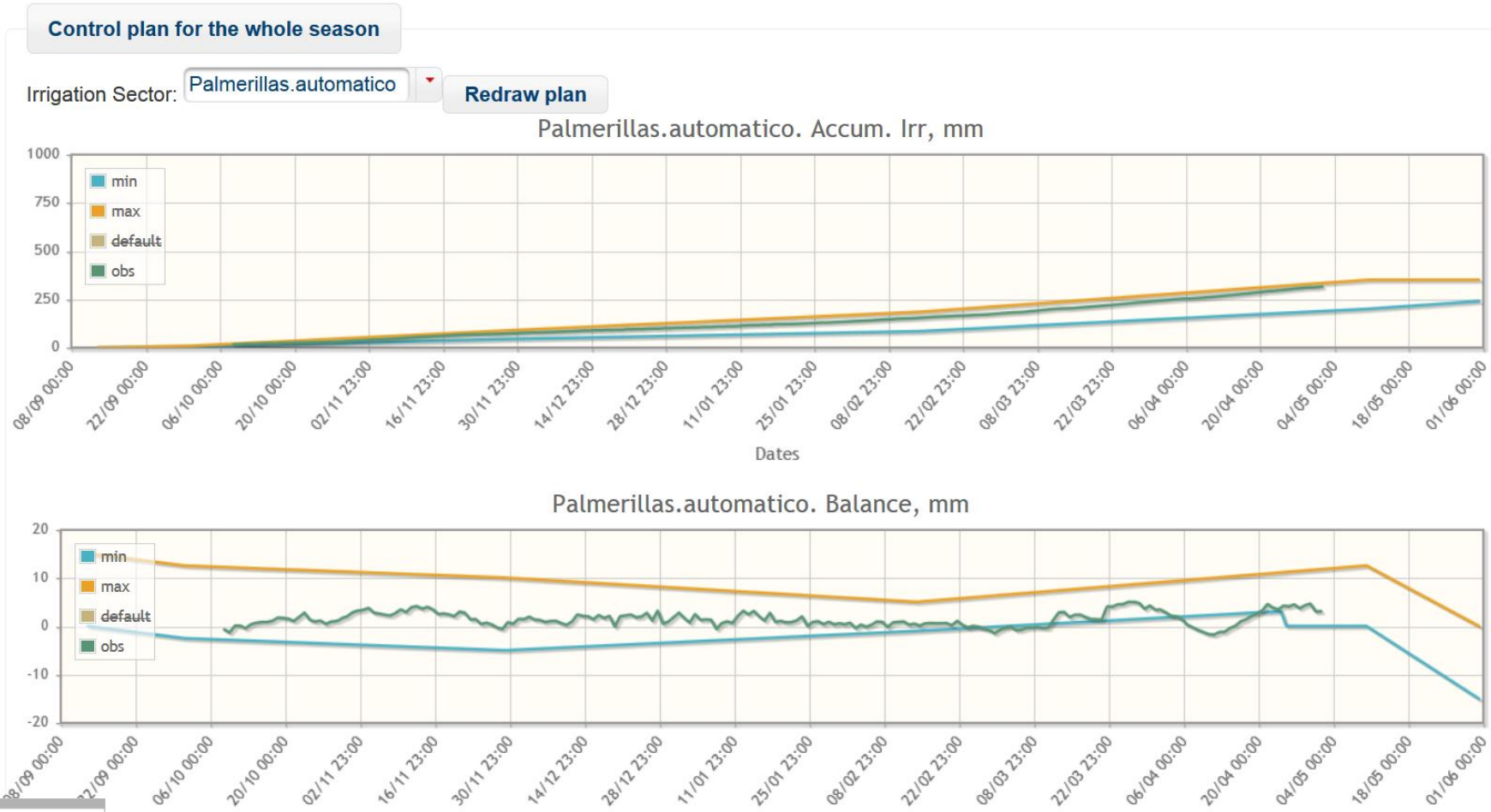
- IRRIX requires basic knowledge about how to irrigate a given crop cycle
- IRRIX estimates crop water requirements
- IRRIX monitorizes soil water and salt status using soil sensors



IRRIX requires basic knowledge about how to irrigate greenhouse, soil-grown vegetable crops (tomato)

IRRIX requires data of maximum and minimum (along the whole crop cycle):

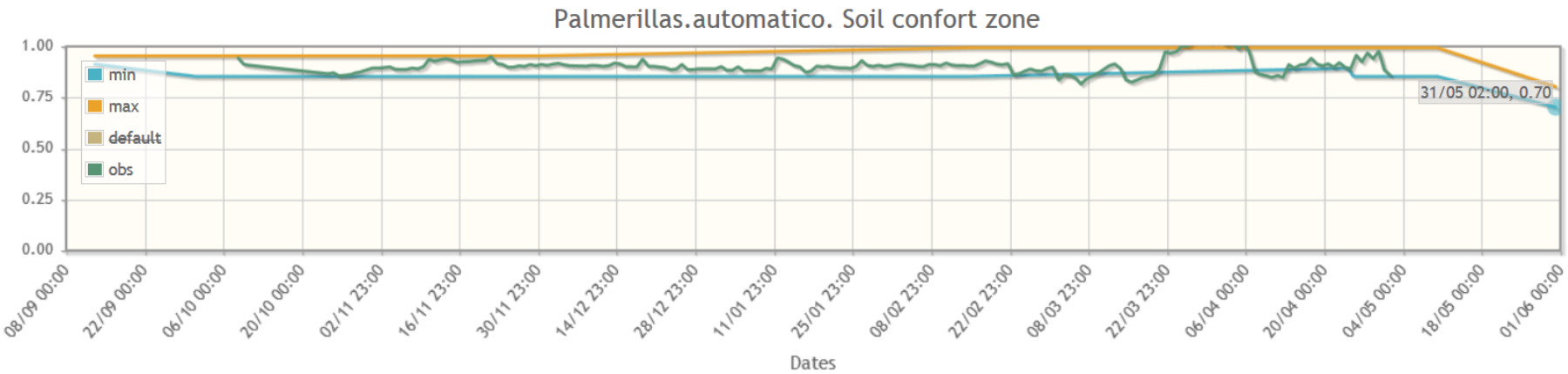
- **Cumulative irrigation water supply (mm)**
- **Weekly water balance (mm): water supply - water requirement**

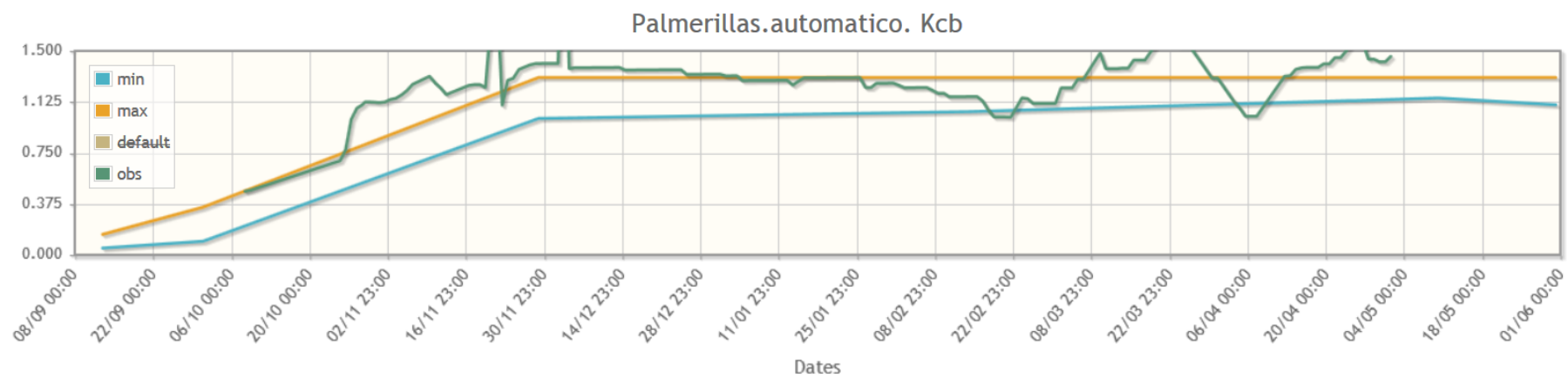


IRRIX requires basic knowledge about how to irrigate greenhouse, soil-grown vegetable crops (tomato)

IRRIX requires data of maximum and minimum (along the whole crop cycle):

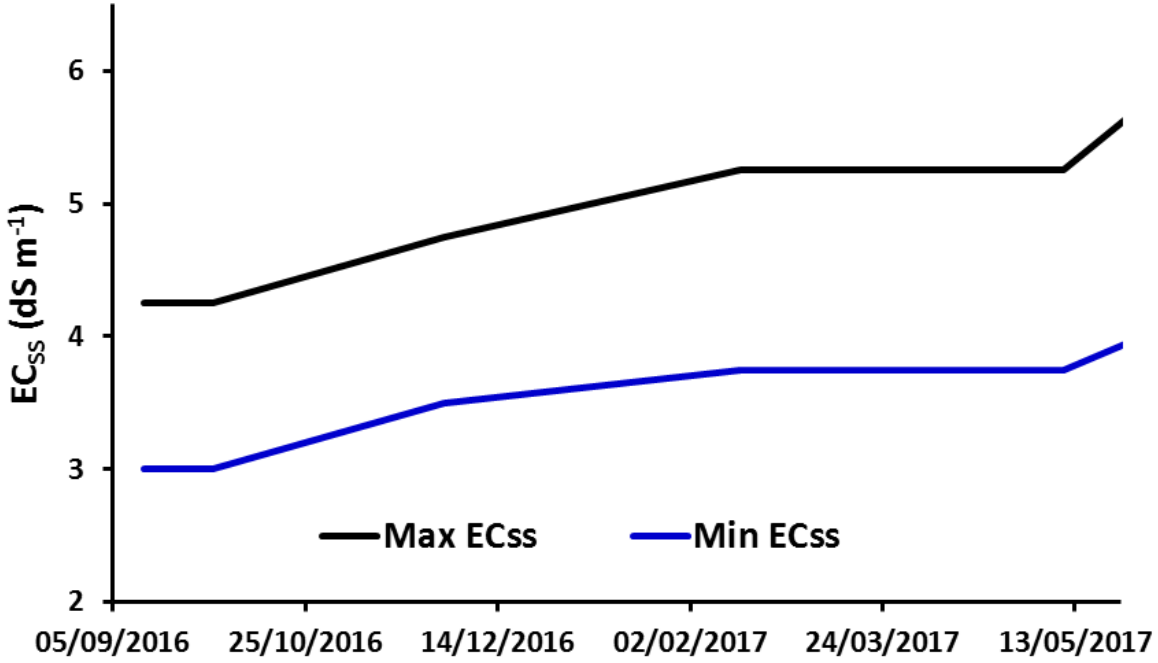
- **Soil water content (relative values)**
- **Basal crop coefficient (Kcb)**





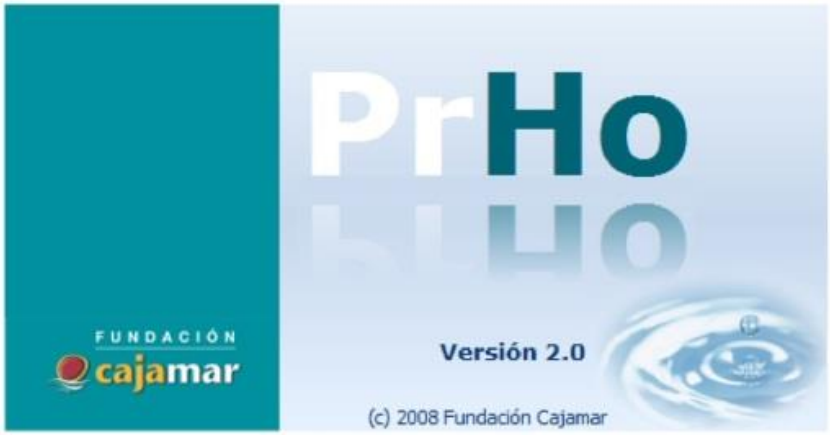
IRRIX requires basic knowledge about how to irrigate soil-grown, greenhouse vegetable crops: tomato

IRRIX requires data of maximum and minimum of soil solution electrical conductivity (EC_{SS}, dS m^{-1}) throughout the crop cycle



IRRIX continouosly estimates the crop water requirements with PrHo

IRRIX receives continouos data of greenhouse shortwave radiation for ETo calculations



For Julian days (JD) $\leq$ 220: $\mathbf{ET_o = (0.288 + 0.0019 \times JD)} \times \tau \times G_o$

For Julian days (JD) > 220: $\mathbf{ET_o = (1.339 + 0.00288 \times JD)} \times \tau \times G_o$

τ : greenhouse transmission to shortwave radiation
$\mathbf{G_o}$: outdoor shortwave radiation (mm d^{-1})

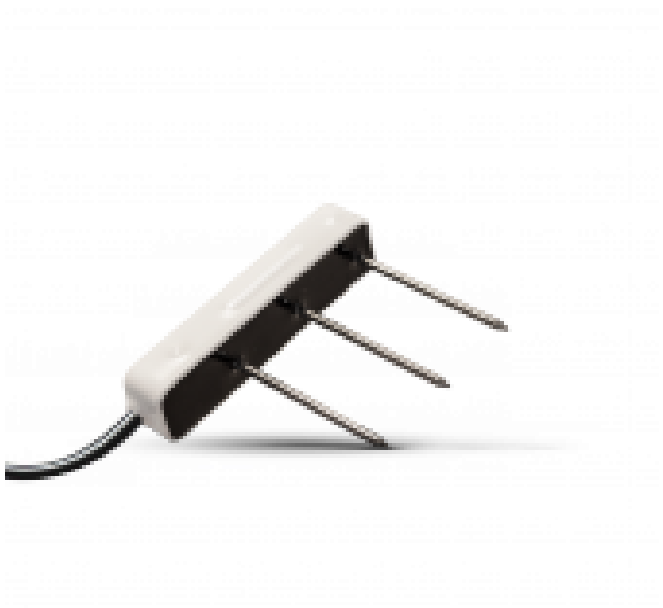
(Bonachela et al. 2006; Fernández et al., 2010)

IRRIX monitorizes soil water and salt status using soil sensors

IRRIX receives continouos data of soil water content and bulk electrical conductivity

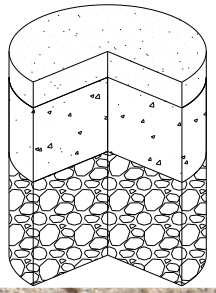
GS3 sensors (Decagon Devices Inc., Washington, USA):

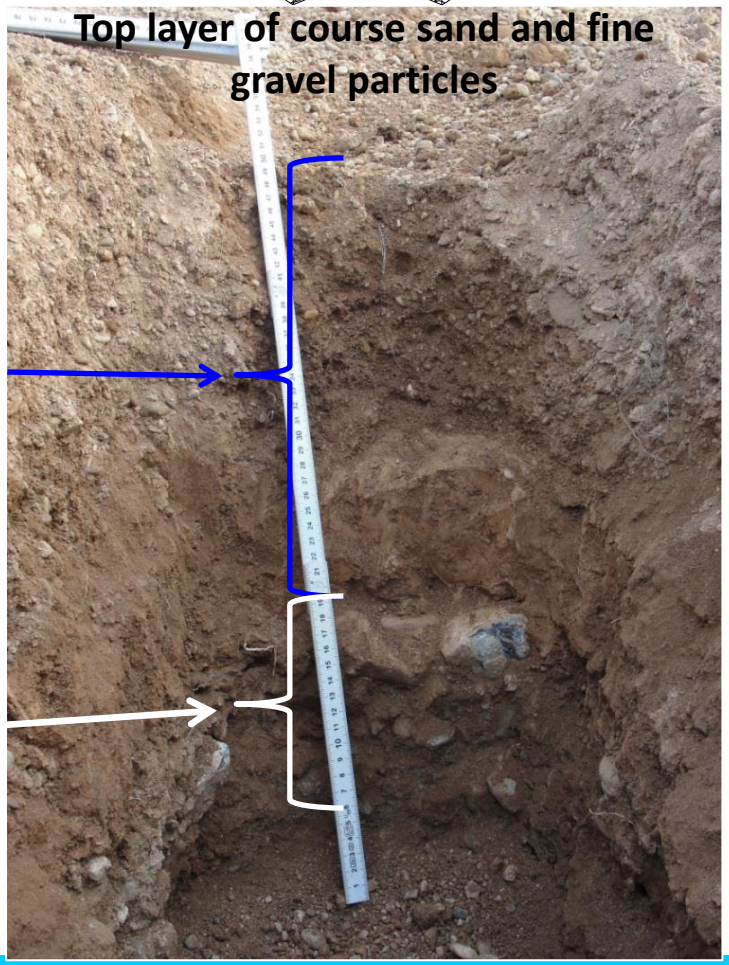
- **Measurements of volumetric soil water content (%)**
- **Estimations of soil solution electrical conductivity (EC_{SS}, dS m^{-1}). Hilhorst (2000)**



Experimental set-up

- Two tomato (*Solanum lycopersicum* L.) cycles: 2016 and 2016/17
- Parral-type (raspa y amagado) greenhouse
- Enarenado soil with an imported silty-clay loam layer
- Irrigation water of 1.6 dS m^{-1} EC mixed with fertilizers (fertigation)





Imported silty-clay loam layer (0.4 m)

Naturally occurring gravelly sandy-loam soil

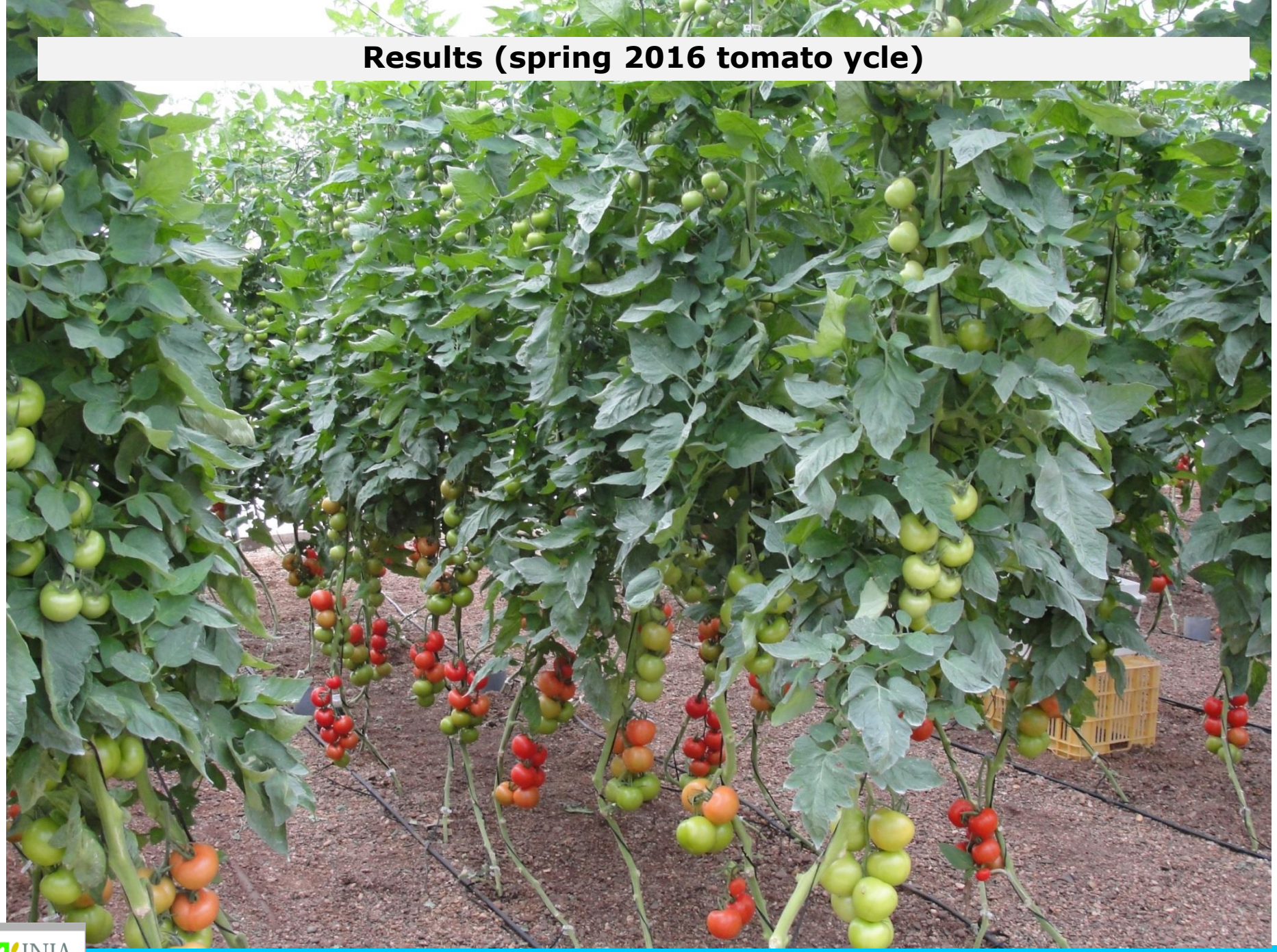
Treatments:

- **Automated irrigated tomato using IRRIX**
- **Control: Tomato crop irrigated with real-time ET values** (Orgaz et. al 2005; Fernández et al., 2010), which were corrected taking into account real-time data of soil matric potential (Ψ_m, kPa) and soil solution electrical conductivity (EC_{SS}, dS m^{-1}).

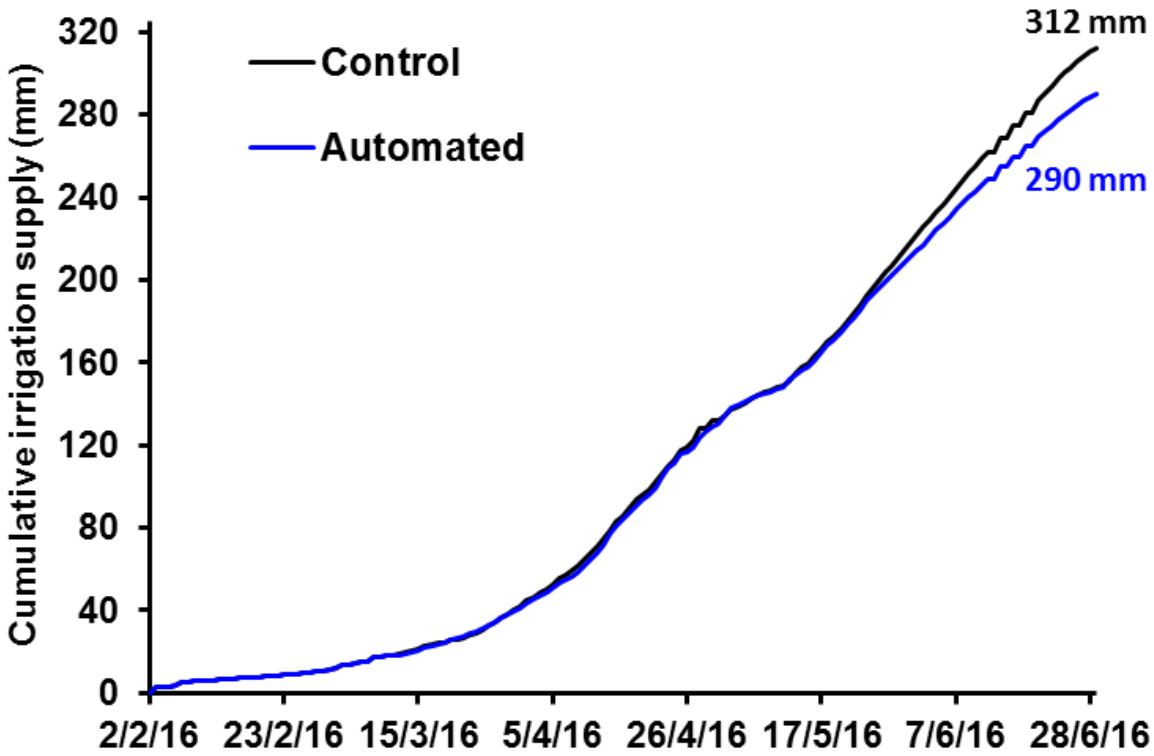
Additional measurements:

- **Soil matric potential** (Ψ_m, kPa) using digital tensiometers (model ISRRSU-300 Irrometer)
- **Soil solution electrical conductivity** (EC_{SS}, dS m^{-1}) using suction cups (model SSAT, Irrometer, Riverside, CA, USA)

Results (spring 2016 tomato ycle)



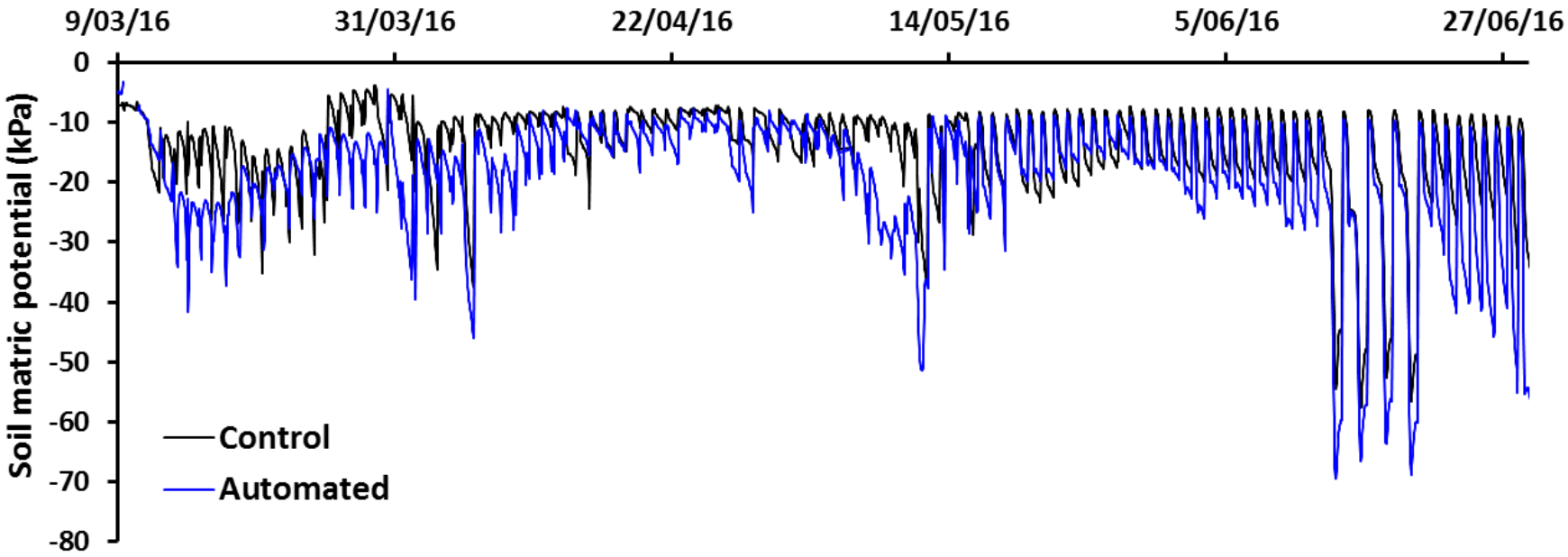
Cumulative irrigation water supply (2016 tomato cycle)



Similar values of cumulative irrigation water supply for both irrigation treatments, except at the of the cycle when they were slightly lower for the automated-irrigated crop

Soil matric potential measured in the centre of the wet bulb

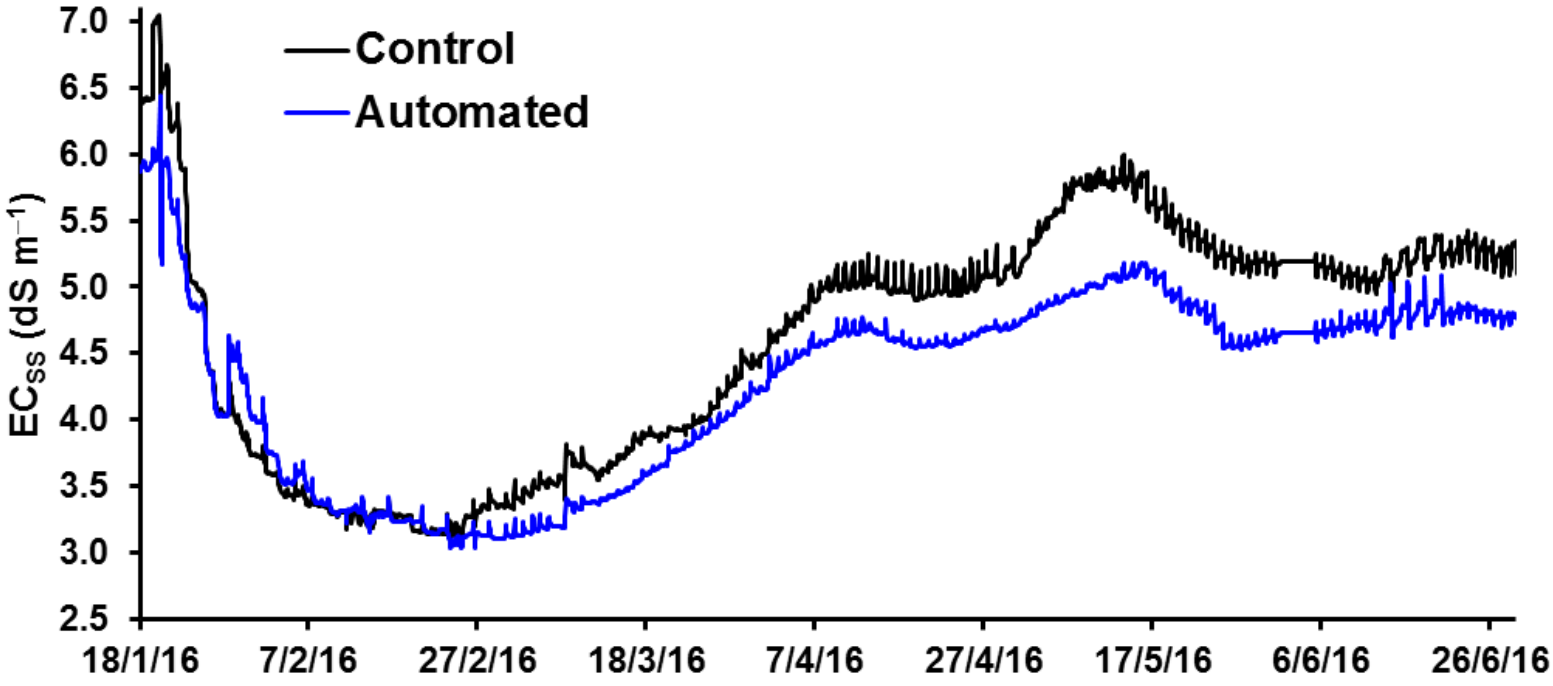
(2016 tomato)



Similar values of soil matric potential (kPa) for both irrigation treatments throughout most of the tomato cycle

Soil solution electrical conductivity (EC_{SS}) estimated from GS3 measurements

(2016 tomato)



Similar EC_{SS} seasonal dynamics, but lower values for the automated-irrigated crop during the second half of the tomato cycle

Shoot dry matter and crop yield (2016 tomato)

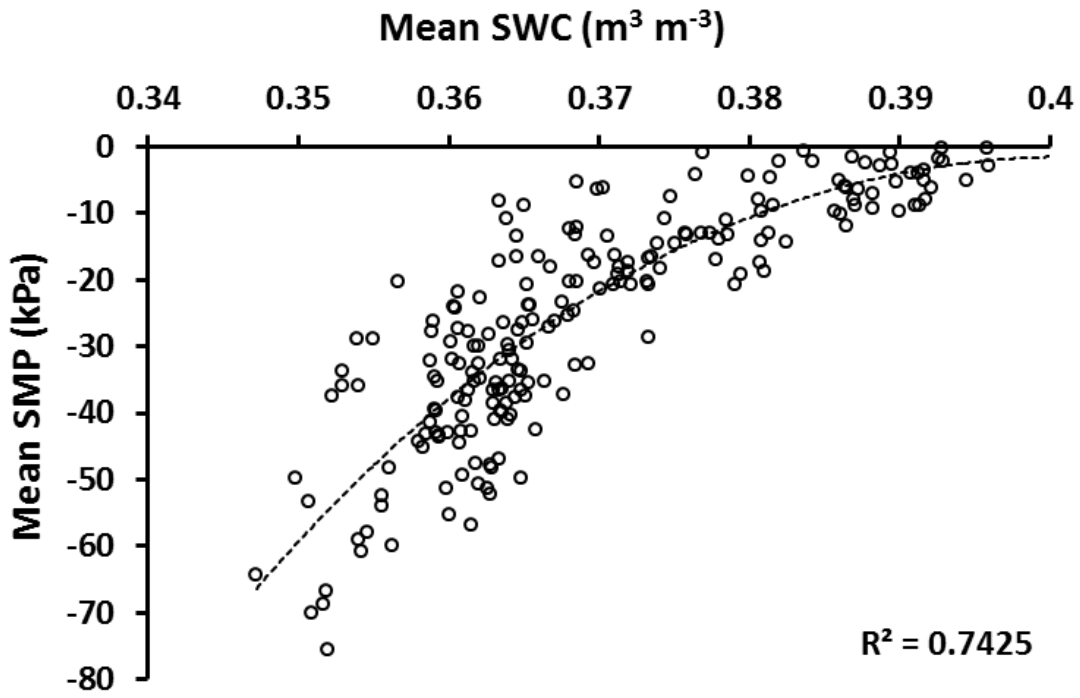
- No significant differences between irrigation treatments for shoot dry matter or shoot dry matter allocation

- No significant differences between irrigation treatments for fresh weight of total, marketable and non-maketable tomato fruits or for marketable yield components

Ongoing works

- ❒ Evaluation of automated irrigation (IRRIX) in salt-sensitive greenhouse crops, such as sweet pepper

- ❒ How to improvement the use of sensor data in automated irrigation programme (IRRIX)

Main drawbacks

❒ Sensor accuracy, sensitivity and representativeness