Effect of high saline irrigation water on the sustainability of barley cultivated in a Mediterranean climate

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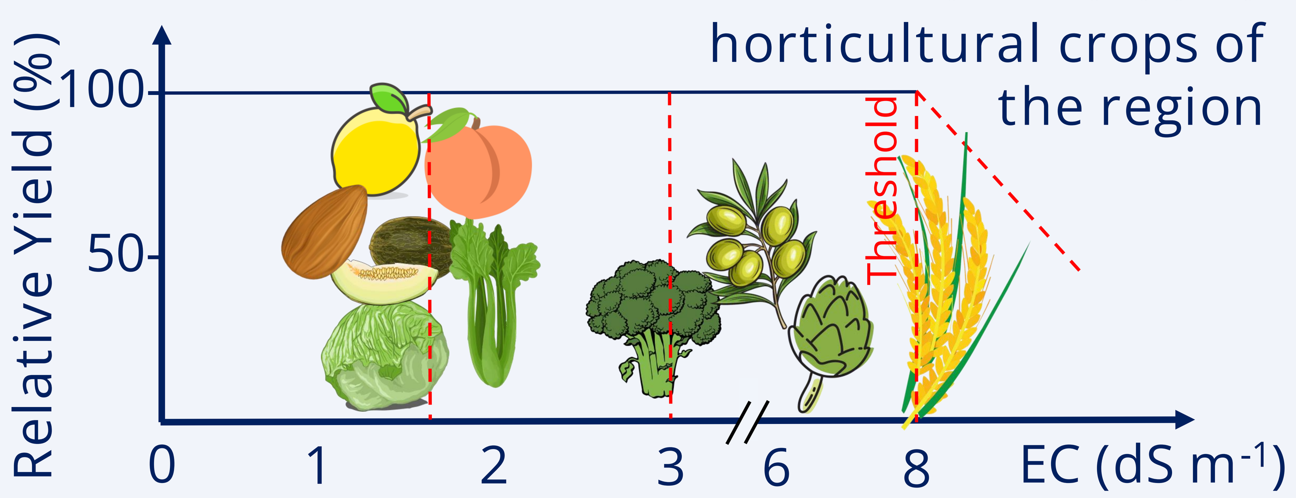
The irrigated agriculture challenge

Semi-arid Mediterranean climates such as 'Campo de Cartagena' (Murcia, Spain) faces a major challenge to maintain the environmental and economic sustainability of the sector due to:

- An almost permanent water scarcity and projections of severe shortages due to climate change.
- High pressure for the use of water resources.
- Poor agricultural quality and high diffuse nitrate contamination of the groundwater:
  Electrical conductivity (EC) ≈6.5 dS m^{-1}
  N (NO_3^-) ≈96 mg L^{-1}



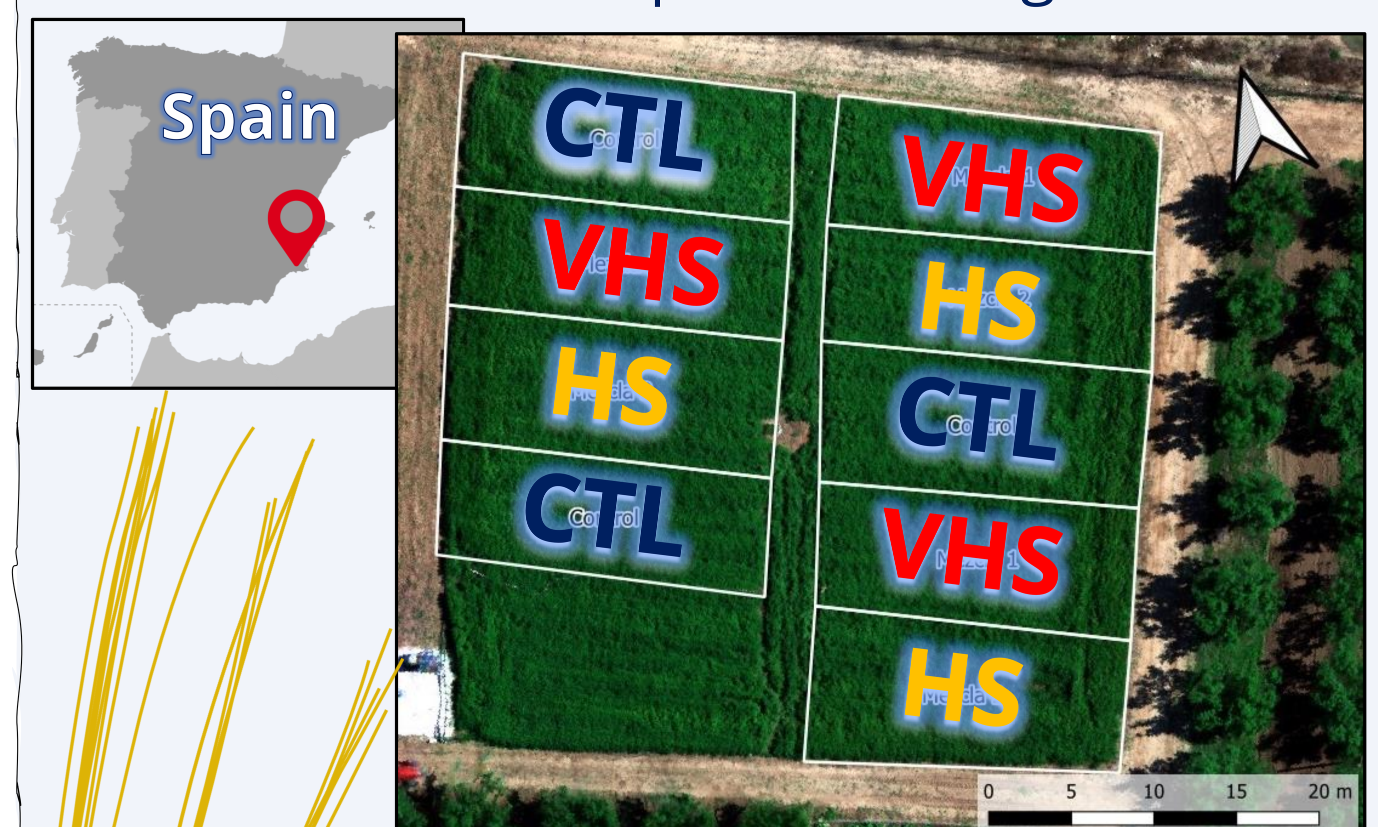
Objective

Evaluate the agronomic response of barley (*Hordeum vulgare* L.) irrigated with high saline water and with the incorporation of continuous monitoring sensors of soil water status and Remote Sensing, to minimize leaching and reduce the pressure on water resources.

Material & Methods

- Barley cv. Shakira.
- Sowing (200 kg ha^{-1}) January 27, 2022.
- High frequency localized irrigation system.
- 1700 m^2 plot.

A completely randomized design was established with 3 treatments (n=3):
***'Control'* (CTL)**, irrigated with surface water with an EC of 1.46 dS m^{-1}.
***'High salinity'* (HS)**, irrigated with a mixture of surface and groundwater to reach an EC of 4.5 dS m^{-1}.
***'Very high salinity'* (VHS)**, irrigated with 100% groundwater with an EC of 6.5 dS m^{-1} and with a total N input of 36.2 kg ha^{-1}.



Irrigation was scheduled to allow a 30% depletion of field capacity in the active root zone.

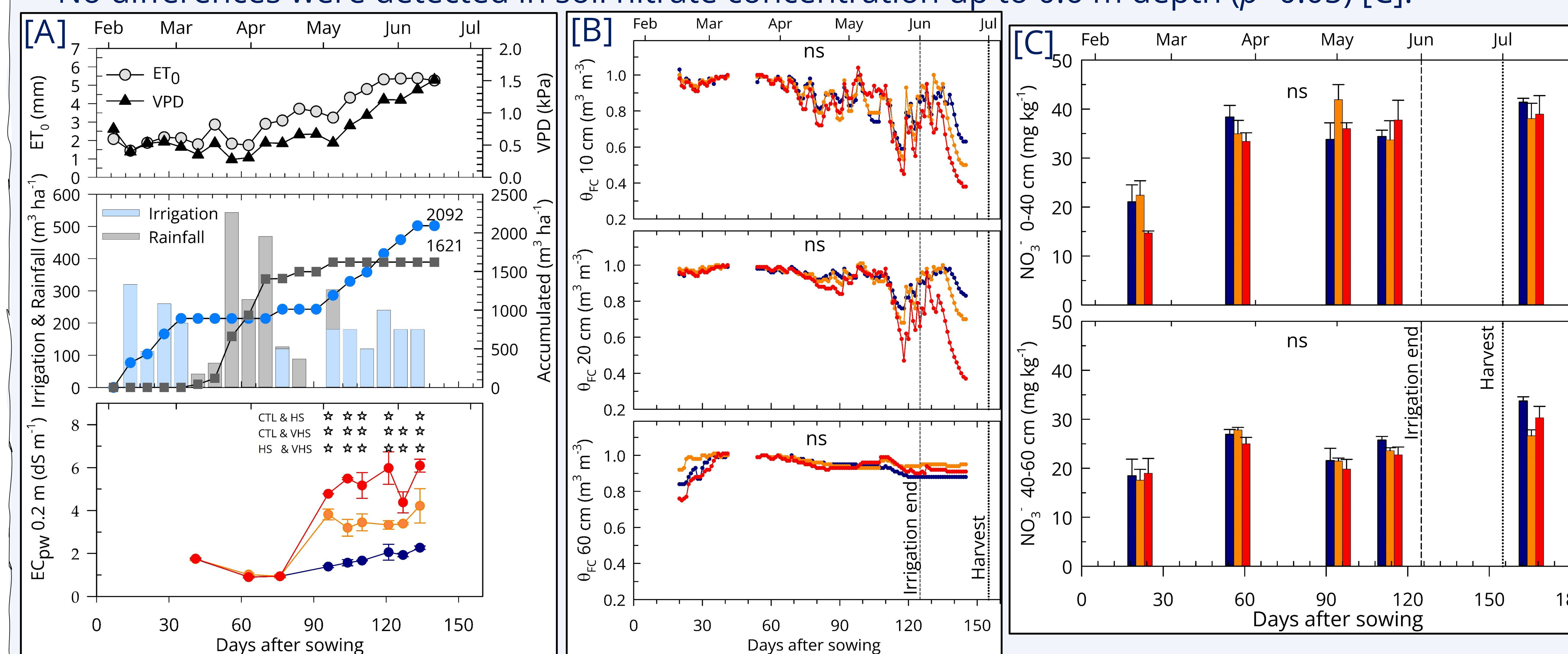
In 'HS' and 'VHS', N supply was equalized via fertigation with ammonium nitrate.

Prior to ANOVA, assumptions were checked and when differences, means were separated by Duncan's test (p < 0.05).

Results & Conclusions

CTL HS VHS

- At the end of the irrigation period, the soil pore water electrical conductivity (EC_{pw}) at 0.2 m depth was significantly higher in proportion to the salinity treatments and the irrigation criteria minimized water and nitrate leaching to at least 60 cm depth [A-B].
- No differences were detected in soil nitrate concentration up to 0.6 m depth (p<0.05) [C].



ET_0: reference evapotranspiration; VPD: vapor pressure deficit and θ_{FC}: soil water content relative to field capacity.
White stars indicate significant differences between treatments and ns: not-significant (p<0.05)

- No differences were detected in the yield parameters. Likewise, the caliber distribution was not affected and the proportion of grains larger than 2.8 mm reached an average of 89.4% [D].
- The grains germination capacity (>99%) and dry protein were not affected (10.4%).
- NDVI ranged from 0.3-0.71 and CGI from 1.5-3.37, both reaching maximum when the crop was fully covered, but no differences between treatments were detected.

[D]

Treatment	Spikes m^{-2}	g m^{-2}	Grains per spike	1000 grains (g)	Yield (t ha^{-1})
CTL	420.8 ±18.9 a	350.3 ±23.1 a	16.32 ±1.26 a	51.48 ±0.55 a	3.50 ±0.23 a
HS	385.3 ±11.1 a	339.7 ±14.3 a	16.90 ±0.25 a	52.13 ±0.34 a	3.40 ±0.14 a
VHS	390.5 ±35.8 a	347.8 ±46.4 a	16.63 ±1.19 a	53.06 ±0.49 a	3.46 ±0.46 a

Our results validate the economic viability of barley cultivation irrigated with highly saline water and, from an environmental point of view, highlight the importance of incorporating quantitative and objective methods for irrigation scheduling to minimize water and nutrient leaching.

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