The Effect of Water Salinity on Transpiration and Photochemistry in *Citrus unshiu* Marc. 'Iwasaki' in Croatia

Domagoj Ivan Žeravica[1], Jelena Baule[1], Patrik Rajndl[1], Ivana Paladin Soče[1], Iva Mračić Raič[1], Mara Marić[1], Jerko Gunjača[3,4], Boris Lazarević[2,3]

[1]*Department for Mediterranean Plants, University of Dubrovnik, Dubrovnik, Croatia*
[2]*Department of Plant Nutrition, Faculty of Agriculture, University of Zagreb, Zagreb, Croatia*
[3]*Centre of Excellence for Biodiversity and Molecular Plant Breeding (CroP-BioDiv), Faculty of Agriculture, University of Zagreb, Zagreb, Croatia*
[4]*Department of Plant Breeding, Genetics and Biometrics, Faculty of Agriculture, University of Zagreb, Zagreb, Croatia*

BACKGROUND

The global climate has undergone rapid changes over the past two decades, affecting various sectors, including agriculture, on a global scale (Simpson et al., 2015; Pan et al., 2020, Balfagon et al, 2021). The rise in sea levels contributes to increased salinity levels, while secondary salinization from irrigation sources poses an escalating challenge in commercial agriculture (Eswar et al., 2019; Mitra et al., 2018). Salt stress exerts morphological, biochemical, physiological, and crop productivity effects (Haokip et al., 2019; Pathania i Singh, 2021). Salinity directly impacts plant photosynthetic activity by reducing CO2 assimilation, stomatal conductivity, nutrient uptake, and PSII efficiency, while increasing cell membrane permeability and electrolyte leakage from cells (Pan et al., 2020, Chaves et al., 2011).
In the Republic of Croatia, citrus fruits represent one of the main crops, predominantly cultivated in the Neretva River Valley, located in the southernmost part of the country (Žeravica i Marić, 2021). Croatia is one of the northernmost commercial citrus growing regions in the world, which presents unique challenges for Citrus production; consequently, the prevailing group of varieties is the Unshiu group, known for its early ripening (Bakarić, 1983). The 'Iwasaki' cultivar, a spontaneous bud mutation of the 'Okitsu' cultivar, is an extremely early and highly productive cultivar (Merino et al., 2015).

Hypotesis: Increased irrigation water salinity negatively impacts the stomatal conductance (GSW) and photosynthetic performance (quantum efficiency of photosystem II (PhiPS2) and electron transport rate (ETR)) of *Citrus unshiu* Marc. 'Iwasaki', with more pronounced effects at locations with higher salinity levels.

MATERIALS AND METHODS

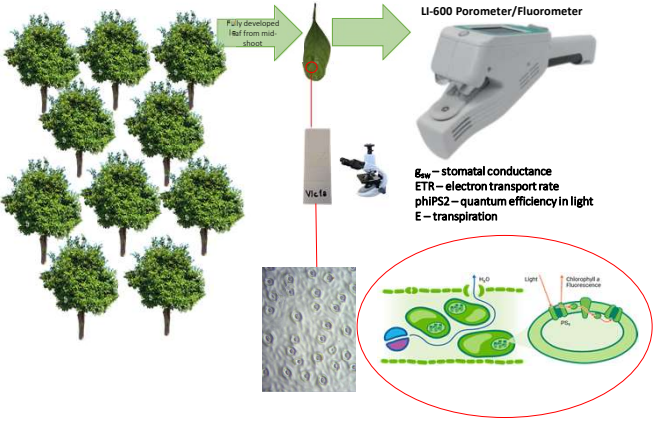
- *Citrus unshiu* Marc. 'Iwasaki': 10 trees in commercial orchards, 2 locations
- The measurements were taken on young leaves after the spring growth phase of the shoots, betwen 8.45 and 11 AM

Statistical analysis:

- Gsw, PhiPS2 and ETR data were subjected to statistical analysis by using the mixed model considering years, locations and their interaction as fixed effects, while trees within locations were considered as random effect. While ETR data were analyzed using the original scale, gsw and PhiPS data had to be log10 transformed. Post-hoc comparisons of means were conducted for significant effects and presented (back-transformed) on the original scale.

Table 1. EC contreation – locations and years

EC (µS cm-1)	Bostanac	Vidrice
2023	685	5132
2024	747	5549



RESULTS

Table 2. Analysis of Variance (ANOVA) for Stomatal Conductance (gsw)

Source	Sum of Squares	Mean Square	NumDF	DenDF	F value	
Year	0.05012	0.05012	1	96.688	0.3926	n.s.
Location	1.68083	1.68083	1	18.044	13.1663	**
Interaction	2.20148	2.20148	1	96.688	17.2446	***

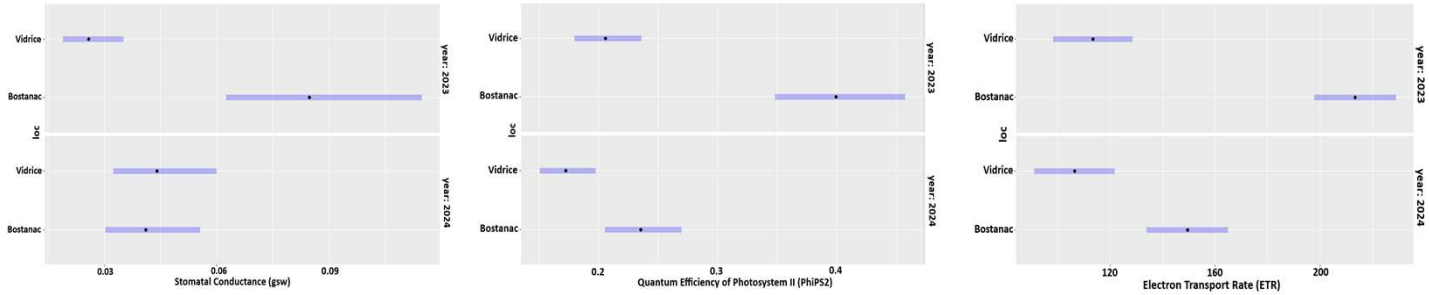
Table 3. Analysis of Variance (ANOVA) for Quantum Efficiency of Photosystem II (PhiPS2)

	Sum of Squares	Mean Square	NumDF	DenDF	F value	
Year	0.70732	0.70732	1	98	30.7793	***
Location	1.05558	1.05558	1	18	45.9339	***
Interaction	0.17368	0.17368	1	98	7.5575	**

Table 3. Analysis of Variance (ANOVA) for Electron Transport Rate (ETR)

Source	Sum of Squares	Mean Square	NumDF	DenDF	F value	
Year	36.178	36.178	1	94.594	23.956	***
Location	119.425	119.425	1	18.709	79.081	***
Interaction	23.298	23.298	1	94.594	15.428	***

***** - significant at P = 0.001, ** significant at P = 0.01, n.s. - not significant**



Comparison of location means within years using 95% confidence intervals. Overlapping bars designate no significant differences.

CONCLUSIONS

The statistical analysis confirms that higher irrigation water salinity negatively affects the physiological parameters of *Citrus unshiu Marc.* 'Iwasaki', as hypothesized. At Vidrice, where water salinity was significantly higher, stomatal conductance (*gsw*), quantum efficiency of photosystem II (PhiPS2), and electron transport rate (ETR) were consistently lower compared to Bostanac, where salinity levels were much lower. The interaction between year and location further highlighted that salinity had a more pronounced effect in 2023, suggesting that environmental conditions can exacerbate the impact of high salinity. These results demonstrate that lower salinity levels are crucial for maintaining optimal photosynthetic performance and overall plant health, especially in regions where secondary salinization from irrigation is a growing concern. Effective water management is therefore essential to mitigate the adverse effects of salinity on crop productivity.

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