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Grapevine Plants' Metabolic Traits Assessment Under Rational and Deficit Irrigation Using a *Sinorhizobium meliloti*-based Biostimulant

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INTRODUCTION

Irrigation deficit stress relief is an urgent need in the face of climate change, and this could be achieved by water management and the application of biostimulants that enhance plant growth even in harsh conditions [1,2]. This research aims to investigate the biostimulant potential of *Sinorhizobium meliloti* on the growth and metabolic traits of *Vitis vinifera* L. var. "Debina" under normal and deficit irrigation conditions.

METHODS

Grapevine cuttings *V. vinifera* L. var. "Debina" was collected from the Zitsa viticultural zone (Ioannina, Greece), planted in 9 L pots, and irrigated with a drip irrigation system. The biostimulant formulation Hydromaat, (Futureco Bioscience) containing *S. meliloti* cepa B2352 (2% w/w) was used in the experiment. The treatments were arranged as described in Figure 1. The leaf area, proline, total chlorophyll (TCHL), and total phenolic content (TPC) were analyzed to get grapevines' metabolic and growth insights.

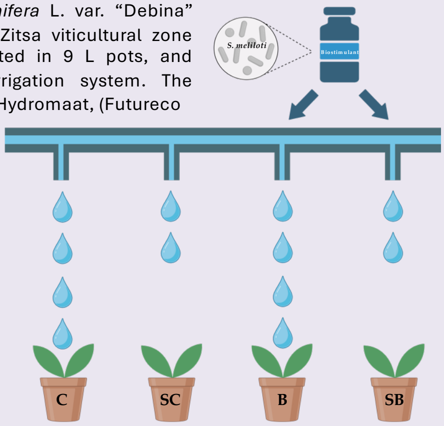

Figure 1. Schematic representation of the treatments: (C) Control treatment (100% of AW), (SC) Stressed Control treatment (57% of AW), (B) biostimulant treatment (100% of AW and *S. meliloti* application), (SB) Stressed Biostimulant treatment (57% of AW and *S. meliloti* application).

RESULTS & DISCUSSION

Under optimal irrigated conditions, PGPR treatment (B = 3449.37±89.44 cm^2), showed a larger leaf area, with a statistically significant difference to the control (C=1707.60±207.36 cm^2) (F=48.83, df=5, p<0.001) (Figure 2). The beneficial effect of PGPR on the grapevine's leaf area under abiotic stress has also been showcased in the study of Horák et al. 2021 in which a higher leaf weight was observed [3]. The proline accumulation on grapevine leaf tissues was higher at Irrigation deficit conditions in the *S. meliloti* treatment (SB) compared to the SC, with a statistically significant difference, both on day 56 (F=201.400, df=5, p<0.001) and day 122 (F=321.13, df=5, p<0.001) as shown in Figure 3.

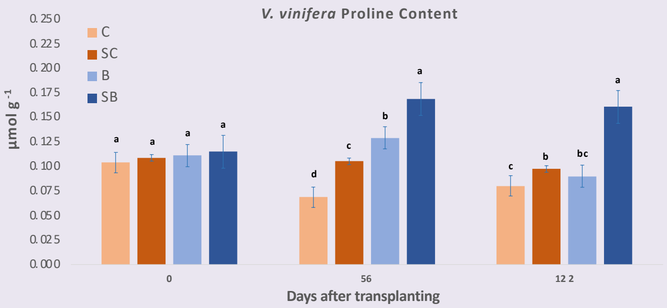

Figure 3. Proline content (μmol g^{-1} ±SE) of *V. vinifera* (sampling at 0, 56, and 122 days after transplanting). Different letters between treatments indicate significant differences according to the Bonferroni test (p≤0.05)

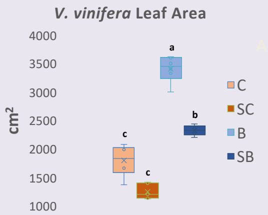

Figure 2. Leaf area (cm^2) of *V. vinifera* at the end of the experiment. Different letters between treatments indicate significant differences according to the Bonferroni test (p≤0.05)

This fact may portray the prevention of grapevine oxidative damage in abiotic conditions, with proline acting as a defense mechanism. The increased proline levels in grapevine leaves as a result of PGPR application has been shown in the work of Theocharis et al. 2012 in cold stress conditions [4].

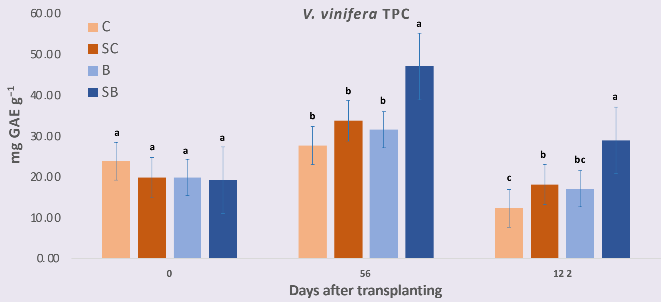

Figure 4. Total Phenolic Content (mg GAE g^{-1} ± SE) of *V. vinifera* (sampling at 0, 56, and 122 days after transplanting). Different letters between treatments indicate significant differences according to the Bonferroni test (p≤0.05).

PGPR applications in plants as biostimulants may moderate the oxidative damage by modulating the antioxidant content and reducing ROS levels, enhancing the plant metabolism [5]. In this research, TPC was more enriched in the biostimulant treatments. As shown in Figure 4, the higher TPC on treatment SB was at day 56 (46.99±1.17 mg GAE g^{-1}) compared to SC (33.69±0.28 mg GAE g^{-1}) with a statistically significant difference (F=68.37, df=5, p<0.001).

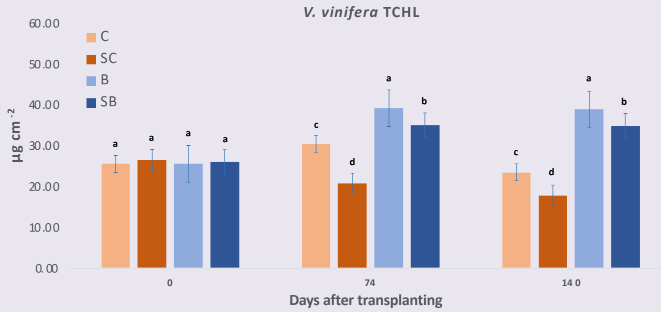

Figure 5. Total Chlorophyll Content (μg cm^{-2} ± SE) of *V. vinifera* (sampling at 0, 56, and 122 days after transplanting). Different letters between treatments indicate significant differences according to the Bonferroni test (p≤0.05)

Total phenolic components act as a metabolic defense shield [6], improving antioxidant enzyme production [7], in abiotic conditions such as the irrigation deficit. An analogous outcome of antioxidant enzyme production has been displayed in the study of Bianco & Defez 2009 where *S. meliloti* was applied in salt-stressed barrelclover plants [8]. Grapevine TCHL was higher in the case of optimal than deficit irrigation conditions for both treatments. But in the case of deficit irrigation, the TCHL on SB treatment was higher, especially on day 74 (35.16±0.19 μg cm^{-2}) compared to SC (20.84±0.45 μg cm^{-2}), with a statistically significant difference (F=430.75, df=5, p<0.001) (Figure 5). The biostimulant effect of *S. meliloti* may be based on its contribution to biological nitrogen fixation [9] and the regulation of cytokinins under abiotic stress [10], acting in the physiological processes such as chlorophyll accumulation [11]

CONCLUSIONS

In this study, the growth of grapevine with the addition of an *S. meliloti* biostimulant, both under optimal and irrigation deficit conditions, displayed a statistically significant improvement of proline TPC, TCHL, and leaf area. This is encouraging for crop stress control as the PGPR-based biostimulants can be integrated into agricultural water management practices.

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