A biostimulant based on seaweed and yeast extracts mitigates water stress effects on different crops

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INTRODUCTION

Water stress is one of the most problematic stressors worldwide. Climate change is increasing the lack of water, especially because of the global warming and frequent droughts (1). Water-shortage phenomena slow down plant development and are responsible for yield and product quality losses (1). The need to find a way to counteract water stress is the focus of many studies. Biostimulants could represent a quick and effective approach to increase tolerance in plants, thanks to the synergy effect of different bioactive components (1).

AIM OF THE WORK

The aim of this research was to study the effect of ERANTHIS®, a biostimulant based on brown seaweeds (*Ascophyllum nodosum* and *Laminaria digitata*) and yeast extracts. This product was preliminary tested on different crops and then we decided to focus on tomato (*Solanum lycopersicum* Mill.), a crop highly susceptible to drought. Plants were grown in greenhouse under optimal and water stress conditions and the stress mitigation effect of ERANTHIS® was investigated by evaluating physiological (stem water potential) and biochemical (ROS scavenger enzymes, hydrogen peroxide, proline, abscisic acid) parameters.

MATERIALS AND METHODS

Biostimulant treatment

1

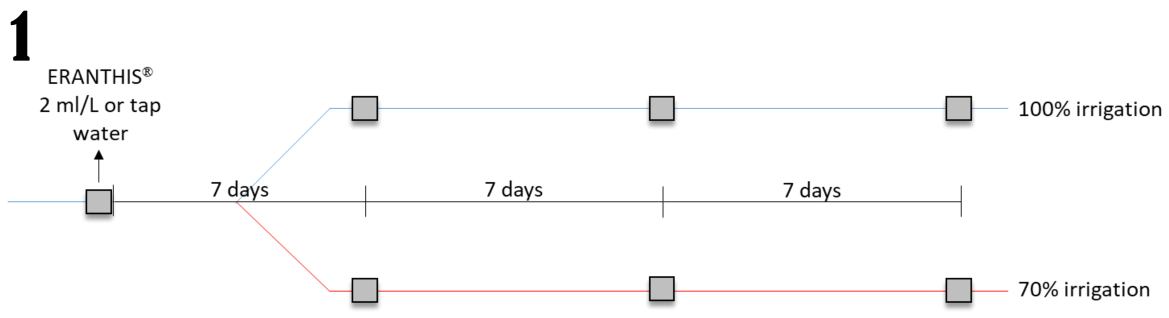

Fig. 1 Scheme of ERANTHIS® foliar applications on tomato plants. Control unstressed and stressed plants were watered with tap water.

Stem water potential measurement

2

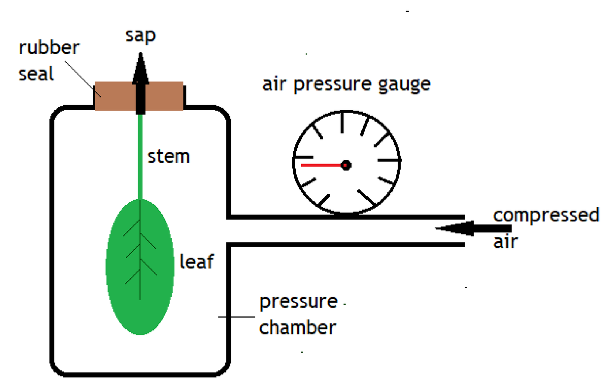

Fig. 2 Stem water potential (ψ_{stem}) was measured using a Scholander-type pressure chamber (Soil Moisture Equipment Corp., Santa Barbara, CA, USA). One leaf for plant was placed in a humidified plastic bag covered with aluminium foil to stop transpiration. After 30 min leaves were cut and allowed to equilibrate in dark conditions before the measurement.

Biochemical parameters

3

Fig. 3 ROS scavenger enzyme (Superoxide Dismutase, SOD, EC 1.15.1.1, Peroxidase, POX, EC 1.11.1.7, Glutathione-S-Transferase, GST, EC 2.5.1.18) activities, Hydrogen Peroxide (H_2O_2) and Proline content were evaluated spectrophotometrically. Photosynthetic pigments were extracted using 96% ethanol and quantified spectrophotometrically

Abscisic Acid (ABA) was extracted using a mix of 80% (v/v) methanol, acidified with 1% (v/v) acetic acid and analyzed by UHPLC-MS/MS. For experimental details see Campobenedetto et al (2).

RESULTS

Stem water potential and ψ/ABA correlation

Stem water potential (ψ_{stem}) is one of the most important parameters to evaluate plant water status. In **Fig. 4** is reported how, in presence of stress, ψ_{stem} ~~is~~ strongly decreased in comparison to well irrigated control plants (-148%). Differently, stressed plants treated with ERANTHIS® showed values statistically less reduced (-49%).

At the same time, **Fig. 5** shows the interaction between ψ_{stem} and ABA. Abscisic Acid is an hormone involved in plant water stress response and its rising content is correlated to more negative ψ_{stem} values. It is interesting to note that the highest stress level was observed in the untreated/stressed plants (red square), whereas ERANTHIS®-treated/stressed plants showed less ABA content in leaves and a higher stem water potential values (green square). These results lead to hypothesize a stress mitigation effect exerted by this biostimulant.

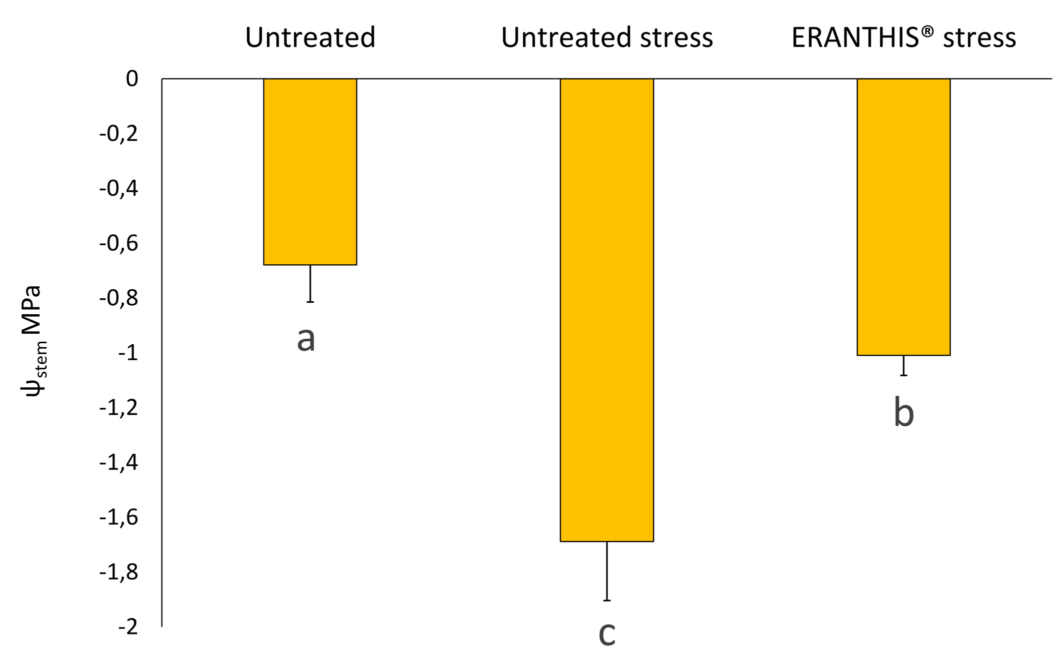

Fig. 4 Stem water potential of untreated/unstressed, untreated/stressed and treated/stressed plants. Bars with different letters indicate significant different values at $p<0.05$ as measured by one-way ANOVA followed by Tukey's HSD post hoc test

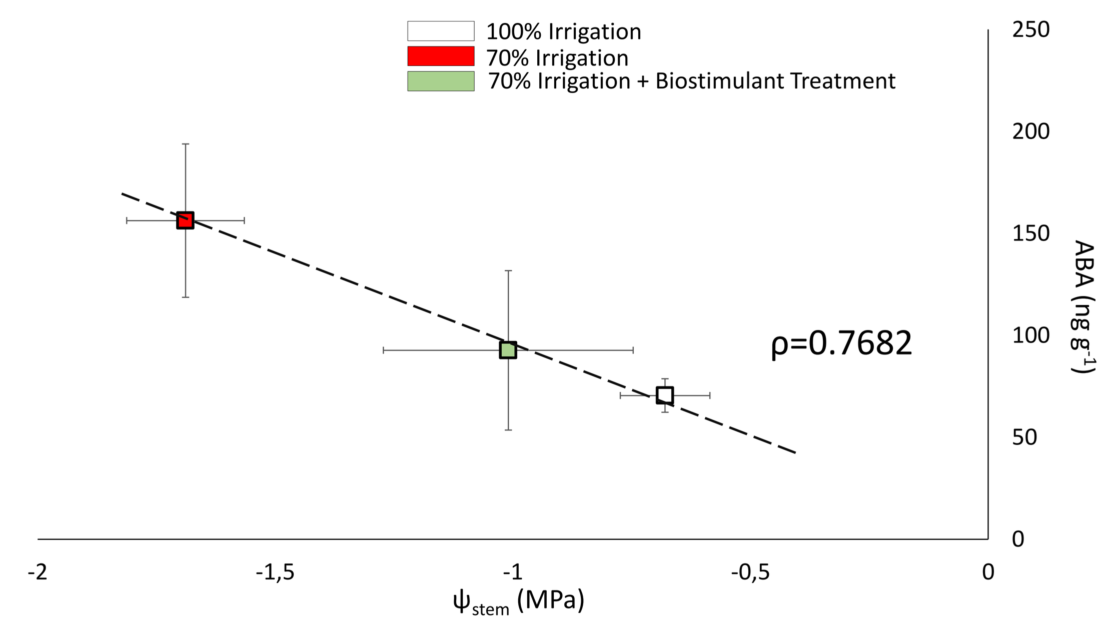

Fig. 5 Stem water potential (ψ_{stem}) and abscisic acid (ABA) correlation The white shapes represent untreated plants with 100% full water supply, the red ones untreated/stressed plants and the green ones treated/stressed plants. The dotted lines show the correlation between ABA content and ψ_{stem} The ρ coefficient was calculated dividing the covariance of the two variables by the product of their standard deviations.

Biochemical parameters

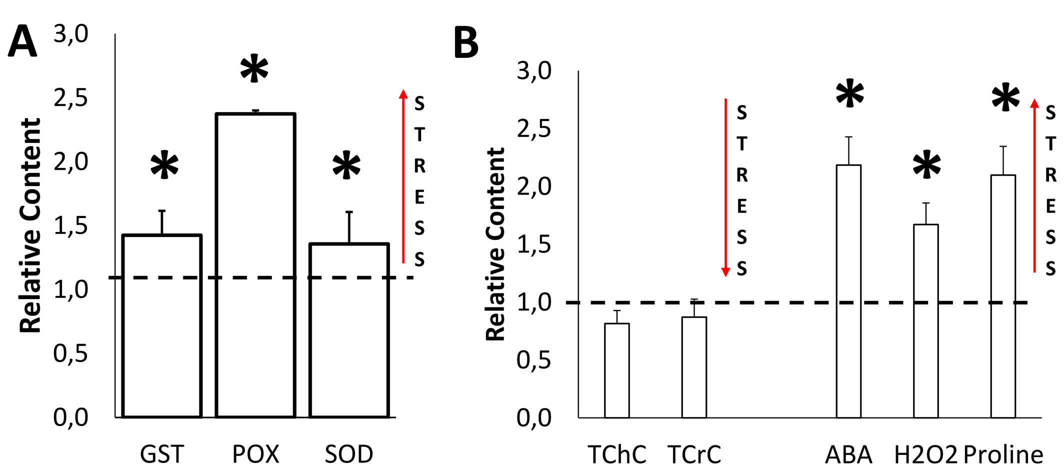

Fig. 6 Water stress effect on enzymatic (A) and non-enzymatic (B) parameters. Data are expressed as relative content, comparing the measurements obtained by untreated/stressed and untreated/unstressed (bars). The dotted line indicates the relative value of each parameter related to untreated/unstressed plants. The symbol "*", when present, indicates significant differences ($p<0.05$) between untreated/stressed and untreated/unstressed, as measured by *t*-test.

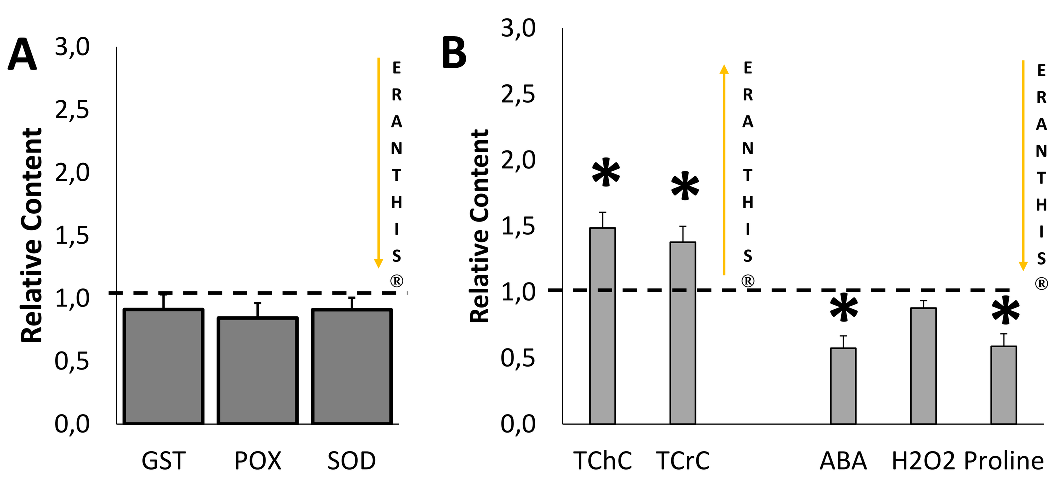

Fig. 7 ERANTHIS® effect on enzymatic (A) and non-enzymatic (B) parameters. Data are expressed as relative content, comparing the measurements obtained by treated/stressed and untreated/stressed (bars). The dotted line indicates the relative value of each parameter related to untreated/stressed plants. The symbol "*", when present, indicates significant differences ($p<0.05$) between treated/stressed and untreated/stressed, as measured by *t*-test.

Water stress significantly increase ROS scavenger enzyme activity, ABA, H_2O_2 and proline content (**Fig.6**), parameters strongly involved in the stress response. Enzymatic and non-enzymatic measurements confirmed ERANTHIS® action in mitigating water stress effects (**Fig. 7**). Indeed, treated/stressed plants showed lower values of ROS scavenger enzyme activity, ABA, H_2O_2 and proline content if compared to unstressed/stressed plants. At the same time, photosynthetic pigments were decreased by stress effect (Fig.6B), while increased in stressed plants treated with ERANTHIS® if compared to untreated/stressed plants (Fig. 7B). In conclusion, the treatment seems to be beneficial for plant development and product quality.

CONCLUSIONS

+ ROS scavenger enzyme activity
+ H_2O_2, ABA, proline
– Photosynthetic pigments
– Stem water potential

– ROS scavenger enzyme activity
– H_2O_2, ABA, proline
+ Photosynthetic pigments
+ Stem water potential

REFERENCES

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2) Campobenedetto, C et al. (2021). A Biostimulant Based on Seaweed (*Ascophyllum nodosum* and *Laminaria digitata*) and Yeast Extracts Mitigates Water Stress Effects on Tomato (*Solanum lycopersicum* L.). *Agriculture*, *11*(6), 557.