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PlantScreen™ Automated Phenotyping Systems

Novel high-throughput approach in discovering and understanding the mode of action of plant biostimulants

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Background

Plant-derived natural products represent an interesting source of new plant biostimulants. In this trial, selected candidate substances, protein hydrolysates of plant origin, were tested for their biostimulant activity in tomato plants (*Lycopersicon esculentum*) Hybrid FI CHICCO ROSSO at the whole plant level by image-based in depth analysis of plant growth and photosynthetic performance. To enhance our understanding on tomato overall performance following biostimulant application at control and drought conditions, experimental protocol was developed based on using high-throughput non-invasive imaging technologies developed at Photon Systems Instruments (PSI, Czech Republic). Range of morpho-physiological phenotypic traits were monitored on daily basis via PlantScreen™ automated plant phenotyping platform and were used to characterize the mode of action of the selected groups of biostimulants. Here we present data for control plants treated during growth with 9 different types of biostimulant.

Results

Fig.3 A-B Growth performance and photosynthetic efficiency of tomato plants following the biostimulant application. Color segmented RGB images (3-A) and ChlF1 pictures for F_m (3-B) in false colors are shown. Time refers to days of phenotyping.

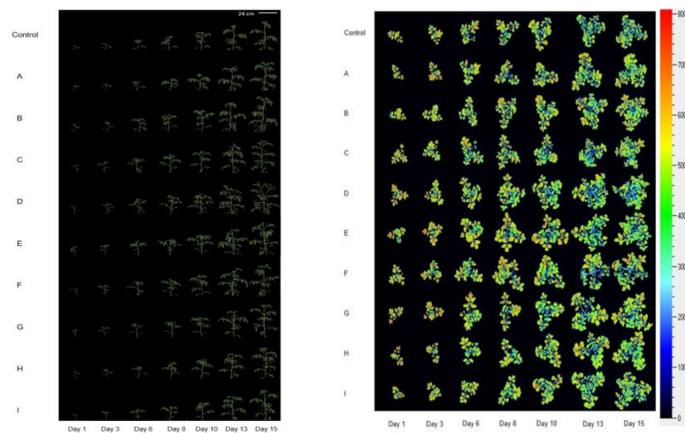
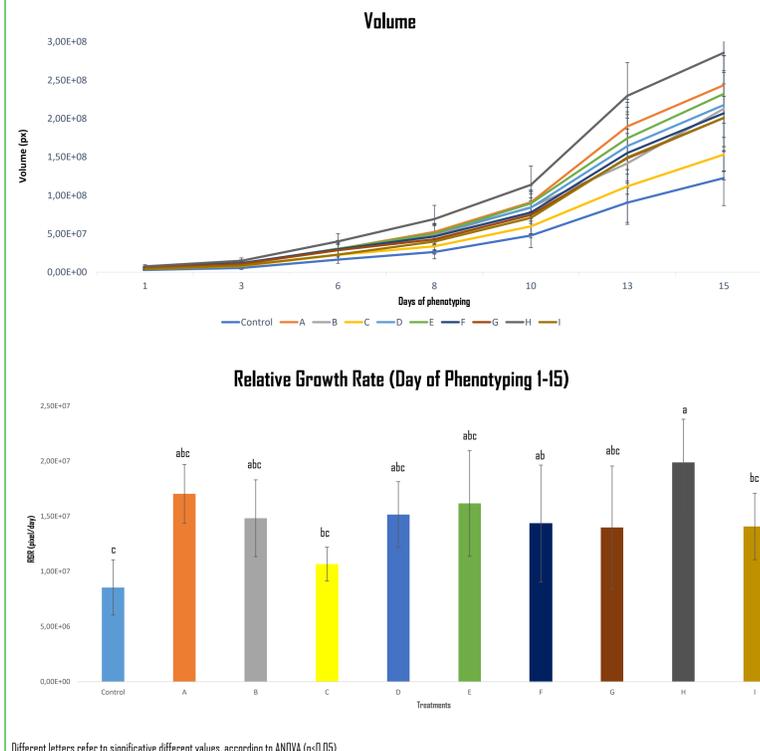


Fig.4A-B The volumes of the plants have been calculated using the total number of green pixels (shoot area) from the images acquired both by top view RGB camera and by multiple angles image acquisition from side view RGB camera.



Different letters refer to significant different values, according to ANOVA ($p < 0.05$)

Conclusions

European Biostimulants Industry Council (EBIC) defined plant biostimulants as follows: "Plant biostimulant means a material which contains substance(s) whose function when applied to plants or the rhizosphere is to stimulate natural processes to benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and/or crop quality." In agreement with this definition, the application of those 9 different biostimulants was supposed to improve growth performance and optimize the productivity of the tomato plants used in this experiment. The ANOVA test, performed to recognize significant differences between the volumes of the plants, showed that, at the end of the experiment (day 15), only the tomatoes treated with A, E and H biostimulants were significantly bigger than the control ones; but, looking at the significance for the Relative Growth Rate of the different plants, was the application of the compounds F and H that caused a steadier RGR if compared to that of control plants. Various biostimulants have been reported to stimulate plant growth not only by increasing plant metabolism, stimulating germination, and increasing the absorption of nutrients from the soil, but also enhancing photosynthesis; next, we will analyze chlorophyll fluorescence data for the evaluation of photosynthetic efficiency and we will correlate the data with the growth performance results we obtained.

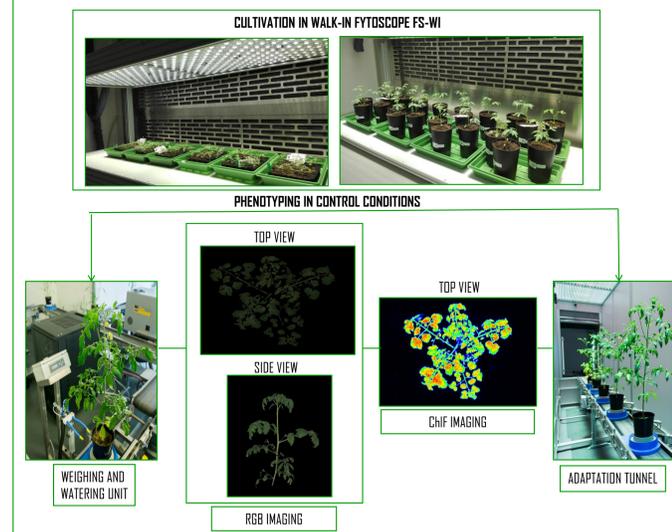
Materials and Methods

Following stratification in 4°C, seeds were placed into controlled environment (**Step-in FytoScope FS-SI**) and kept at 22°C, 60% Rh and 250 $\mu\text{mol}/\text{m}^2/\text{s}$ with 16h/8h light/dark regime. Prior initiation of phenotyping, plants were watered on day 6, 7, 12 and 14 after placement into the light. On day 7 and 14, plants were watered to full saturation with a fertilizer. 20 days old plants were transplanted into 3L pots. 22 days old plants were transferred to PlantScreen™ Modular System with 6 replicates per treatment. **9 types of biostimulants (A-I) plus control group were applied twice to tomato plants by spraying** (at 26 days and 33 days old plants). Prior and following the biostimulant application plants were regularly screened using the calibrated top and side view RGB camera and kinetic chlorophyll fluorescence camera for photosynthetic performance quantification. Plants were regularly watered using the automated watering and weighing station.

Fig.1 Plant cultivation and automated phenotyping protocol



Fig.2 Phenotyping protocol in PlantScreen™ Modular System included RGB analysis for morphological and growth analysis, Chlorophyll Fluorescence (ChlF) measurement for photosynthetic performance analysis, watering and weighing of the pots.



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