INTRODUCTION

- In horticultural crops, including leafy vegetables, deficit irrigation and generally inadequate water supply have been reported to disrupt several morphological, biochemical and physiological processes leading to delayed plant development and reduced crop productivity (Roughani et al., 2013).
- Biostimulants are capable of enhancing flowering, plant growth, fruit set, crop productivity, and nutrient use efficiency especially under biotic and abiotic stressors (Colla and Roughani, 2015). Their main components may be macroelements, hormones, enzymes, proteins, vitamins, amino acids, and other compounds (Edmeades, 2002).
- Lettuce is an important crop which is widely consumed in various salad mixes. Therefore, its demand is constantly increasing since it contributes to the nutritional part of the diet (Kenny and O’Beirne, 2009).
- In the present study, we evaluated the effect of five biostimulant products with varied composition, including the control treatment with no biostimulant application, on field-grown lettuce plants (Lactuca sativa L.: Romaine type cv. Doris) under deficit irrigation conditions.

METHODOLOGY

- The experiment took place at the experimental farm of the School of Agricultural Sciences of the University of Thessaly. Lettuce (Lactuca sativa L.) plants from the Romaine type variety cv. Doris were transplanted on April 1, while harvest took place on May 27.
- In the present study five biostimulant products with varied composition were evaluated (e.g. seaweed extracts+macronutrients+amino acids (SW); humic-fulvic acids (HF); Si+Ca; Si (S); vegetable proteins+amino acids (VP)) and control treatment (no biostimulant added (NB)). The biostimulants were provided by Agroplus S.A., Greece. The frequency of biostimulant application was 5 days, 15 and 25 days after transplantation. The lettuces were under deficit irrigation conditions (Control treatment: rain-fed plants; I1: 50% of field capacity; I2: 100% of field capacity).
- All treatments were applied with foliar spraying except for biostimulants containing humic-fulvic acids (e.g. HF) and those contained CaO and SiO2 + Calcium Utilization, Mobilization and Translocation Factor (e.g. SiC) which were applied through fertigation.
- The growth parameters tested were plant weight (apical part), number of leaves, fresh and dry weight of leaves, leaf area index (LAI), specific leaf area (SLA), and SPAD index.

RESULTS AND DISCUSSION

Figure 1. Plant height fluctuation of lettuce plants at three sampling dates.

Figure 2. SPAD index values of lettuce plants at harvesting.

- After each application of the tested biostimulants, the height of lettuce plants was recorded as shown in Figure 1. According to this Figure, at all three dates it was observed that the biostimulants SI and HF resulted in the highest plant height under rain-fed conditions. In addition, in case of deficient irrigation the biostimulant SI presented the highest plant height.
- In the last sampling date, the treatments of the SI, SW, HF, NB as well as of the VP were not statistically significant in the case of plants that were rain-fed.

Figure 2 presents the chlorophyll content (SPAD index values) in lettuce leaves before at harvest. SPAD values increased when plants treated with vegetable proteins+amino acids (VP) at rain-fed conditions or seaweed extracts+macronutrients+amino acids (SW) at deficit irrigation (I1: 50% of field capacity).

- A noteworthy observation is that all biostimulants showed higher levels of chlorophyll under the rain-fed conditions compared to full irrigation as well as in relation to the treatment without biostimulants which yielded the highest levels of chlorophyll under deficit irrigation.

<table>
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<th>Table 1. Growth parameters of Romaine lettuces.</th>
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<td>Roman type cv. Doris</td>
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- In general, the biostimulant with humic-fulvic acids (HF) yielded positive results in terms of plant weight, leaf weight, LAI as well as in rain-fed plants in the case of number of leaves and the dry matter content. On the other hand, the SLA was found to increase under full irrigation conditions.
- Equally positive results were presented by the vegetable proteins+amino acids (VP) in the case of rain-fed plants regarding the total number of leaves, total weight of leaves and the SLA values, while in the case of LAI and dry matter content the deficient irrigation (SI) recorded the best results.
- Total plant weight, weight of leaves and LAI were the highest under the half irrigation treatment (I1) for plants treated with the seaweed extracts+macronutrients+amino acids (SW) treatment.
- The number of leaves increased for the plants that received half irrigation (I1) and SI.
- The highest dry matter content and SLA values were recorded for plants that did not receive biostimulants (NB) under rain-fed or full irrigation (I2) conditions, respectively.
- Comparing the weight of leaves for each biostimulant and irrigation level, the results between the biostimulants HF, SW, SI as well as the NB treatment did not differ significantly in the case of deficit irrigation, as well SI and VP in the case of rain-fed conditions.

CONCLUSIONS

- In summary, our results indicate that the biostimulant with seaweed extracts+macronutrients+amino acids (SW) combined with deficient irrigation (SI) presented the highest values in terms of plant weight, leaf weight, LAI as well as the chlorophyll content in lettuce plants.
- According to SPAD values, the biostimulants treatments performed higher values of chlorophyll in the case of rain-fed plants compared to those that were fully irrigated (I2). This finding indicates that biostimulants alleviated water stress which did not affect the plant’s normal functions.
- Also, the biostimulant with SI presented the higher plant height under deficit irrigation (I1) as also the greatest number of leaves.
- In general, all biostimulants showed a better response to deficit irrigation and to rain-fed plants compared to those with full irrigation in almost all measurements.
- Each biostimulant may act differently depending on the irrigation conditions as well as on the tested species or variety. Therefore, continuous research on biostimulants as well as on deficit irrigation is needed in order to provide useful information regarding the water use efficiency of crops and the alleviation of the effects of water shortages on crop productivity.

REFERENCES


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