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The role of biostimulants in the fertilization program in eggplant

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ABSTRACT

Seaweed-based biostimulants have the potential to stimulate the growth and development of young plants and increase plant resistance to stress induced by abiotic factors, such as drought or high temperatures, due to their rich content in macro and microelements, in phytohormones and in plant essential aminoacids. In the present experience, we aimed to study the influence of some foliar treatments with seaweed biostimulators on fruit weight, number of fruits per plant and eggplant yield. For the treatments, three seaweed-based biostimulators were used, Agrocean B, Auxi 4C and Kelpak, each product containing a different species of seaweed (*Laminaria digitata* (Huds.) Lamour., *Ascophyllum nodosum* (L.) Le Jolis. and *Ecklonia maxima* (Osbeck) Papenfuss). The treatments with the product Agrocean B (*Laminaria digitata* (Huds.) Lamour.) determined a 46.60% increase in production, compared to the untreated variant. Significant increases were also caused by treatments with the product Kelpak (*Ecklonia maxima* (Osbeck) Papenfuss), which led to a 32.37% higher yield.

Keywords*:* biostimulants, eggplant, seaweed, yield, fruit weight

INTRODUCTION

Eggplant (*Solanum melongena* L.) have become, in the last 50-60 years, more and more well-known in Romania, due to the high preferences of consumers, as well as the fact that this species finds favorable conditions for cultivation, both in the field, as well as in protected spaces, which ensures good economic efficiency. In the open field, it is recommended to place crops in the southern part of our country. Eggplant is a nitrogen and potassium loving species (Munteanu, 2003; Stan et al., 2003, Tudor et al., 2009), being at the same time affected by magnesium (Munteanu, 2003), iron, boron and molybdenum (Tudor *et* al., 2009) deficiencies. The specific consumption of eggplant is 6-7 kg N, 1-1.5 kg P_2O_5, 6-7.5 kg K_2O, 0.2-0.5 kg CaO and 0.6-0.8 kg MgO, for the formation a ton of fruit (Apahidean and Apahidean, 2001; Tudor *et al*., 2009). In general, it is recommended to make a basic fertilization, by incorporating into the soil by plowing, with 40-60 t/ha of fermented manure (Munteanu, 2003; Voican *et al.,* 2006). Two or three foliar fertilizations can be carried out, after the appearance of flower buds, to complete the required nutrients

(Munteanu, 2003). One of the main advantages of foliar fertilization is the ease with which nutrients are metabolized, unlike fertilization applied in the soil (Fageria *et al.,* 2009).
The transition to an ecological, sustainable agriculture with minimal negative impact on the environment is very topical. Biostimulants based on seaweed can be used successfully because they are rich in organic substances, micronutrients, aminoacids and phytohormones (Battacharyya *et al.,* 2015; Crouch and Van Staden, 1993; Trinchera *et al.,* 2014; Verkleij, 1992). Some species of seaweed also have antibacterial, antifungal, antiviral or even antinematodic and insecticidal effects (Hamed *et al.*, 2018). The most common form of presentation of this type of biostimulants is the seaweed extract (Battacharyya *et al.,* 2015). Some studies indicate the potential of obtaining favorable results through the use of seaweed-based biostimulants in eggplant, which determined the increase in plant height, leaf area, number of fruits and fruit size, both in field culture (Abd El-Gawad and Osman, 2014), as well as in protected spaces (Khazaal and Rashed, 2018).
Laminaria digitata (Huds.) Lamour., *Ascophyllum nodosum* (L.) Le Jolis (Blanco-Pascual *et al.*, 2014) and *Ecklonia maxima* (Osbeck) Papenfuss (Stirk *et al.*, 2014) are three species of brown seaweed, and which are included in the composition of some commercial biostimulants.
There are few studies on the influence of biostimulators with seaweed from the *Laminaria digitata* (Huds.) Lamour. species. The use of this species in combination with *Ascophyllum nodosum* (L.) Le Jolis led to the reduction of the stress caused by the lack of water in tomatoes (Campobenedetto *et al*., 2021).
Biostimulants based on *Ascophyllum nodosum* (L.) Le Jolis were among the most studied in horticultural research. Positive results were obtained regarding the use of this seaweed at pepper yield (Eris *et al.*, 1995), at tomatoes yield (Ali *et al*., 2016). It was found that treatments based on *Ascophyllum nodosum* (L.) Le Jolis can improve the quality of eggplant fruits, by improving the content of sugars and anthocyanins (Pohl *et al.*, 2019, a) and have a positive influence in stimulating flowering (Pohl *et al.*, 2019, b).
Studies with biostimulants based on *Ecklonia maxima* (Osbeck) Papenfuss have shown that their use can cause a significant increase in tomato yield (Cozzolino *et al.*, 2021).

MATERIALS AND METHODS

The present experience was carried out at Research and Development Institute for Vegetable and Flower Growing Vidra, Romania, Ilfov county.
There was studied the influence on the eggplant yield of some types of biostimulants based on seaweed. Three seaweed-based products were used for the foliar treatments. Each of the products contains a different species of seaweed. The product Agrocean B is based on *Laminaria digitata* (Huds.) Lamour. extract. The composition of Auxi 4C is based on *Ascophyllum nodosum* (L.) Le Jolis, and the product Kelpak - on *Ecklonia maxima* (Osbeck) Papenfuss.
As biological material was used the eggplant variety Luiza.
The experimental variants and the treatments applied to them are shown in Table 1.

Table 1. Commercial products, concentration used and time between treatments

Experimental variant	Products	Concentration in water solution	Number of foliar treatments
V1	Untreated	-	three treatments at an interval of 10 days
V2	Agrocean B	2 mL / L	
V3	Auxi 4C	2 mL / L	
V4	Kelpak	2 mL / L	

The experimental variants were placed in the field according to the experimental technique, in three replications, in randomized plots. The surface of an experimental plot was 21 m^2. The variants were placed on mulched ground, two rows per furrow. The distance between rows was 70 cm, and the distance between plants was 40 cm.
Phytosanitary treatments were carried out depending on the attack and the warning bulletins issued by the competent authorities, in the concentrations specified for each individual product, being applied in the same way to all variants.
The harvesting of the fruits was carried out in stages, when the fruits reached technological maturity. The fruits were then weighed, making the following measurements:

- the number of fruits per plant;
- the average weight of a fruit;
- yield per hectar.

The statistical analysis of treatment results was processed by the variance analysis method.

RESULTS AND DISCUSSIONS

Eggplants responded differently to treatments based on flowering stimulators. Some treatments caused yield significant increases.
Table 2 shows the influence of different applied biostimulants on the number of fruits per plant.

Table 2. The number of eggplant fruits per plant, depending on the biostimulants used

The variant	Biostimulants used	Medium value (number of fruits)	The difference in percentages compared to the control	Difference compared to control	Meaning
V1	Untreated	3.04	100.00	0.00	Control
V2	Agrocean B	4.13	136.16	1.10	**
V3	Auxi 4C	3.30	108.73	0.27	ns
V4	Kelpak	3.73	122.98	0.70	*

LSD 5% = 0.6273; LSD 1% = 0.8795; LSD 0.1% = 1.2431; (ns = not significant)

The number of eggplant fruits per plant was very significantly influenced by the variant in which treatments were applied with the Agrocean B product (V2), a product that contains an extract from the seaweed species *Laminaria digitata* (Huds.) Lamour.
This variant determined the significant growth with one fruit per plant.
Significant differences were also obtained in the case of variant V4, in which were applied treatments with Kelpak product, the composition of which includes seaweed from the *Ecklonia maxima* (Osbeck) Papenfuss.
The increases obtained in the case of the V3 variant (*Ascophyllum nodosum* (L.) Le Jolis) are not significant.
The influence of treatments with seaweed-based biostimulants on the fruit size is another important objective which must be studied. The eggplant fruit quality is directly reflected in the weight. Increasing the number of fruits on the plant can lead to an undesirable decrease in the weight of a fruit, which would affect their quality.
The influence of the treatments on the weight of eggplant fruits is presented in Table 3.
The weight of a fruit was not significantly influenced. However, there were increases in the case of all treatment options, between 29.75 and 33.25 grams. The greatest weight gain

was obtained in the case of treatments with the Kelpak product (*Ecklonia maxima* (Osbeck) Papenfuss), but they were not enough to be significant.

Table 3. The weight of eggplant fruits, depending on the biostimulants used

The variant	Biostimulants used	Medium value (g)	The difference in percentages compared to the control	Difference compared to control	Meaning
V1	Untreated	307.00	100.00	0.00	Control
V2	Agrocean B	330.50	107.65	23.50	ns
V3	Auxi 4C	329.75	107.41	22.75	ns
V4	Kelpak	333.25	108.55	26.25	ns

LSD 5% = 44.8783; LSD 1% = 62,9202; LSD 0.1% = 88,9327; (ns = not significant)

Table 4 shows the influence of some treatments with biostimulants on the eggplant yield per hectare.

Table 4. The eggplant yield per hectare, depending on the biostimulants used

The variant	Biostimulants used	Medium value (t/ha)	The difference in percentages compared to the control	Difference compared to control	Meaning
V1	Untreated	37.34	100.00	0.00	Control
V2	Agrocean B	54.75	146.60	17.40	**
V3	Auxi 4C	43.47	116.41	6.13	Ns
V4	Kelpak	49.43	132.37	12.09	*

LSD 5% = 10.2222; LSD 1% = 14.3317; LSD 0.1% = 20.2567; (ns = not significant)

Eggplant yield was distinctly significantly influenced by the variant with the Agrocean B biosimulant product (with *Laminaria digitata* (Huds.) Lamour.) (variant V2) were used for foliar fertilization. This led to important yield increases of 46.60%, meaning 17.40 t/ha.
At the same time, significant differences were also obtained in the case of variant V4, in which treatments with Kelpak (with *Ecklonia maxima* (Osbeck) Papenfuss) were applied, which led to increases of 32.37%, meaning 12.09 t/ha.
The V3 variant (Auxi 4C - Ascophyllum nodosum (L.) Le Jolis) determined yield increases of 6.13 t/ha, but these were insufficient to be significant. Although the use of this type of seaweed can increase eggplant yield, different cultivars can have a distinct response, and therefore, not be significantly influenced (Pohl *et al.*, 2019, a).

CONCLUSIONS

The present study showed that seaweed-based biostimulators can be used successfully in the eggplant fertilization program.
The treatments with Agrocean B (*Laminaria digitata* (Huds.) Lamour.) and those with Kelpak (*Ecklonia maxima* (Osbeck) Papenfuss) determined significant increases in eggplant production.
Although there were increases in fruit weight in all treatments applied, these were not enough to be significant.

Anyway, it is recommended to continue and deepen the studies regarding the use of biostimulators based on seaweed in eggplant fertilization.

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