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EFFECT OF THE SEAWEED BIOSTIMULANT KELPAK® ON THE GROWTH OF CUCUMBER

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Abstract

Plant biostimulants that have a good effect on the growth and development of plants, especially when they are under the influence of stress factors. The purpose of the experiment was to study the effect of seaweed extract Kelpak® on the development of cucumbers, greenhouse production, under different forms of treatment. The experiment was carried out in the unheated glass greenhouse in the Sandanski region - a city in Southwestern Bulgaria with an altitude of 296 m, in 2019, with April planting. Biostimulant Kelpak was applied in two directions: 1) for soaking seeds and roots and 2) treatment during the growing season. 6 variants in four replicates were developed: 1) control nontreated plants – (NT); 2) treated seeds (TS); 3) treated seedling roots (TSR); 4) only vegetation treatment (VT); 5) treated seeds + vegetation treatment (TS+VT); 6) treated seedling roots + vegetation treatment (TSR+VT). Visible differences in plant growth occur after the first vegetation treatment. The variant with only treated seeds (TS) had the highest number of leaves (23rd day after transplanting), the highest number of fruits at the first harvest and the longest stem length.

Key words:*biiostimulant, cucumbers, Kelpak, seaweed, seed treatment.*

INTRODUCTION

Since the twelfth century, seaweeds, especially brown algae, have been employed in agriculture with considerable success (Temple and Bomke, 1988).

The ratio of cytokinin to auxin has an impact on morphogenesis; low amounts of cytokinin encourage the creation of roots, whereas high levels encourage the formation of buds (Stirk and van Staden, 2006).

Auxins are believed to promote root growth in a number of plants, whereas a high level of cytokinins encourages growth above ground while leaving roots in an underdeveloped state. More nutrient absorption is correlated with denser roots (Zhao, 2010).

In addition to their direct effects on plants, algal extracts may also indirectly affect plant growth. This happens during soil application, affecting microbiological activity and thus improving plant nutrition (Dhir, 2022).

Warman and Munro-Warman (1993) tested different concentrations of Maxicrop and Micro-Mist 300 and Kelpak seaweed extracts on different vegetable crops. They found that thetreatments did not lead to an improvement in vegetables yield compared to the control option, and even vice versa. The authors indicated that increasing concentrations resulted in even a slight decrease in yields.

Zamani et al. (2013), in their review, summarized that the application of seaweed extracts leads to an increase in stress resistance in most plant crops but indicated that the way in which the extracts act has a beneficial effect on plants.

Bulgari et al. (2019) add that the impact of biostimulants (positive or negative) on vegetable plants in order to improve their resistance against abiotic stress, is the result of many constituent elements. They summarize that the mode of action is understood by the way the plants react, but not only at the physiological level, but also at a deeper level (molecular and biochemical level).

Application of seaweed concentrate (root treatment or foliar spray) has been found to improve cabbage seedling growth (Aldworth and Van Staden, 1987).

El-Gamal et al. (2020) found that treating faba bean with seaweed extracts counteracted drought stress.

Three different seaweed biostimulants were tested on small-fruited tomatoes, applied by foliar spraying three times, and with all three preparations, the early maturity of fruiting and the number of fruits were improved. Mikiciuk, M., & Dobromilska, R. (2014).

A biostimulant called Kelpak is created from the seaweed Ecklonia maxima. Auxins, cytokinins, polyamines, gibberellins, abscisic acid, brassinosteroids, and phlorotannins like phloroglucinol and ecol are among the plant growth regulators found in it. A stronger, healthier plant produces better yields as a result of the combined actions of these substances (Rengasamy et al., 2015).

In a trial of different applications of Kelpak on pepper, it was found that pre-planting seedling immersion in the solution, followed by a three-time vegetative spray, resulted in an increase in fruit number and size (Arthur et al., 2003).

When testing the application of two seaweed extracts on cucumbers, in combination with a low temperature treatment, it was found that the combination of the application of low temperatures for 5 days and the treatment with seaweed extracts had the greatest effect on the flowering of cucumbers (seaforce + seamino). A significant increase in cucumber yield was obtained when treated only with the extracts (seaforce + seamino) from seaweed (Sarhan & Ismael, 2014).

Valencia et al. (2018) proved that foliar treatment of cucumbers with five different seaweed extracts applied as biofertilizers led to improvements in both growth and fruit yield and quality.

In a fertigation applicability test of the seaweed biostimulant True Algae Max (TAM) used in different ratios and combined with NPK (100%) it was found that the extract (applied alone and in combination with NPK) resulted in an increase in cucumber yields (Hassan et al., 2021). In conclusion, the authors conclude that the use of mineral fertilizers can be avoided when applying this biostimulant.

Treatment of zucchini grown in a saline environment with different concentrations of Ecklonia maxima seaweed extract applied as a foliar spray resulted in overcoming stress and increasing plant biomass and yield (Rouphael et al., 2017).

Cristofano, et al. (2021) in their review examining the impact of different biostimulants on Cucurbitaceae, Solanaceae and leafy vegetables summarized that, in general, biostimulants have proven their benefits in improving plant development and increasing yields. But because there are a large number of factors also influencing and controversies taking shape, they conclude that research into the wide variety of biostimulants produced by different types of kelp should continue, broadening the scope and using an interdisciplinary approach. approach.

The purpose of the experiment was to study the effect of seaweed extract Kelpak® on the development of cucumbers, greenhouse production, under different forms of treatment.

MATERIALS AND METHODS

The experiment was carried out in Sandanski. The town of Sandanski (224 m above sea level) is located in the Sandanski-Petrich valley, at the foot of the Pirin Mountains.

The basin has a transitional Mediterranean climate and is one of the warmest places in Bulgaria. The average monthly temperature is the lowest in the month of January and is positive, and the highest is in the month of July. During the experimental period, the average daily temperature for March was 12.5°C, and although it was about +3°C warmer (for a multi-year period), a sharp decrease in minimum temperatures was recorded twice during seedling production. April has temperatures close to normal for this period of the year (14.5°C), only +0.2°C above the norm for a multi-year period. May is cooler compared to average data from previous years (-0.8°C), with an average daily temperature of 17.8°C. June, like April, has temperatures close to normal (only by +0.1°C) for this period of the year (Figure 1).

Precipitation also does not directly affect the growth of plants in cultivation facilities, but like temperature it indirectly affects the micro-climate in greenhouses. March is generally dry with only 4 rainy days and with a total amount of precipitation of approximately 1 mm. 13 rainy days were reported in April and 10 rainy days in May. June has 8 rainy days (Figure 1). .

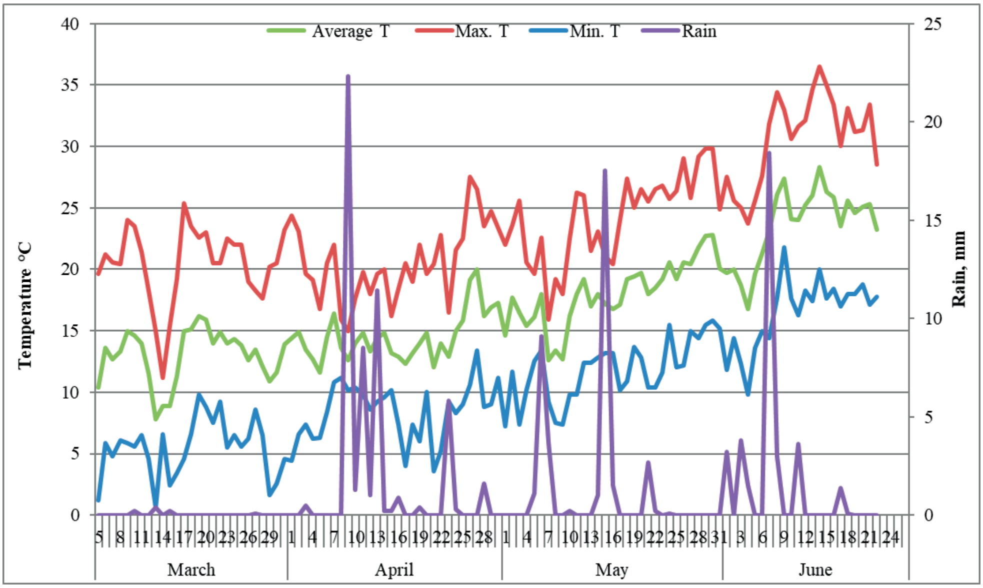

Figure 1. Meteorological situation in the town of Sandanski during the experimental period, 2019

Table 1. Content of phytohormones in biostimulant Kelpak®

Type	Quantity	Unit
Auxins	10.7	µg/L
Cytokinins	0.03	µg/L
Gibberellins	0.6	µg/L
Brassinosteroids	1.1	µg/L
Polyamines	4000	µg/L
Phlorotannins	2200	µg/L

The experiment was set up in an unheated glass greenhouse with a shed width of 3 m. In the month of April, three rows of cucumbers were planted in each shed, with a distance between rows of 110 cm.

For the purposes of the experiment, the variety Defense F1 (Enza Zaden), suitable for summer-autumn production in greenhouses, was used. The hybrid has a vigorous growth, with dark green fruits 30-33 cm long

Biostimulant Kelpak® is a 100% extract of the seaweed Ecklonia maxima (kelp), with a high content of plant hormones (Table 1).

It was applied in two directions: for seed and root soaking and treatment during the growing season, and 6 variants were developed in four replications: 1) control nontreated plants – (NT); 2) treated seeds (TS); 3) treated seedling roots (TSR); 4) only vegetation treatment (VT); 5) treated seeds + vegetation treatment (TS+VT); 6) treated seedling roots + vegetation treatment (TSR+VT).

The dilution of the preparation is 1:100, with a treatment rate of 250 ml/day. Before planting, the seeds are soaked for 6 hours.

Cucumber seedlings obtained from untreated seeds were subjected to pre-planting (TSR) root soaking. Plant roots were soaked in the solution for 10 minutes, immediately before transplanting, until the substrate was completely moistened. The seedling trays were slightly drained of the excess solution, and transplanting in the greenhouse was started.

Planting was carried out on April 15, 2019, with each variant including 90 plants planted 50 cm apart in the row.

Two vegetative treatments were carried out by foliar spray of the cucumbers. The first treatment was carried out on April 28, 2019 (14 days after transplanting), and the second after another 14 days, on 13.05. 2019, as a guideline,

vegetation treatments should be completed before the plants flower.
All elements of the agrotechnics of the experience (tillage, fertilization, irrigation, etc.) are the same for all variants. A ribbon drip hose was used for drip irrigation.
During the growing season of the plants, phenological observations were made: germination, third-fourth leaf, one week after the first vegetation treatment, beginning of flowering, beginning of fruiting. Phenological observations were carried out according to variants.
Biometric parameters were established in four replications of 10 marked plants. The measurements were made when the produce was harvested. The following indicators were tracked: height of plants; average number of leaves; fruit length and diameter; average weight of one fruit; yield

RESULTS AND DISCUSSIONS

Observations on the growth and development of plants begin with the establishment of the experiment.
The beginning of germination started on the fourth day after sowing the seeds, and no differences were reported between the variants. Seven days after sowing the seeds (March 13, 2019), mass germination (97%) was recorded, again with no differences between the individual variants.
In the 3rd/5th leaf phase (29.04.2019), which is 14 days after transplanting the plants, the first vegetative treatment with Kelpak® was carried out. Until this phase occurs, there are no visible differences in the growth of the plants; therefore, the treatment was carried out in one day.
Nine days after the 1st vegetative treatment, leaves were counted to determine if there were differences between the variants. The difference is not great. The variant with treated seeds (TS) has more leaves - on average 10 per plant, the difference with the other variants being 1-2 leaves.
The number of leaves of the plants by variants was counted before the second vegetation treatment and before the first harvest. In these two readings, it was found that the remaining variants differed in number of leaves from the variant with only treated seeds. In TS, the formation of leaves is delayed and at the last reading (41st day after transplanting) the average number of leaves is 30, while in the variants with three treatments (TS+VT and TSR+VT) the number of leaves is the highest and they have an average of 35 leaves. At the last reading of the number of leaves, the difference between the other variants is on an average 1-2 leaves.
A second foliar spray with Kelpak® was made, 14 days after the first treatment (13.05.2019), which is before the flowering of the plants. A few days later, the beginning of flowering was reported, with almost no differences between the individual variants. The differences are mainly in the number of plants with flowers, but the beginning of flowering is observed in almost all variants.
Only the last two variants, with treated seeds and vegetation treatment (TS+VT), as well as treated roots + vegetation treatment (TSR+VT), delayed the setting of flowers.
Start of fruiting: In order to realize sufficient production, the first harvest was carried out simultaneously from all variants on 25.05.19. The difference between the variants was not in the timing but in the amount of fruit picked.
At the first harvest, the variant with treated seeds, which produced the most fruits and, accordingly, the highest yield for this harvest, is selected again.

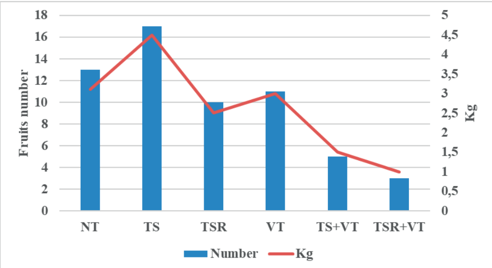

Figure 2. Number of fruits and yield of first harvest of cucumbers

The least fruits were obtained from the last two variants: TS+VT and TSR+VT, which are also due to the delayed entry into the generative phase (Figure 2).
During the harvesting period, biometric measurements of the plants were made.
Of the treated variants, the plants with the highest height were from the variant with only

treated seeds (265 cm). In the rest of the treated variants, a decrease in the height of the plants was noticed compared to the control, and the plants of the variant with treated roots were the lowest (251 cm). In the variants with vegetation treatment, by spraying the leaves, the heights are almost equal, but again, the one with the smallest visibility is the one in which soaking of the roots was also applied (TSR+VT).

This indicates that it is likely that the application of Kelpak®, by soaking the roots, leads to a reduction in plant height.

The biometric measurements of the fruit parameters show small differences in the length of the fruits, while in diameter they are almost the same.

The length of the fruits is in the range of 26.5 to 28.7 cm, and in almost all treated variants, the fruits are of a smaller length (26.5-27 cm) compared to the control (28 cm). Only in the variant with treated seeds and two vegetation feedings are the fruits of greater length (28.7 cm).

As for the diameter, in all variants it moves within narrow limits (3.3-3.5 cm).

The average weight of the fruits ranges from 231 to 242 g. Fruits in all variants with vegetation treatments were heavier than those in the control, while in variants without vegetation treatments they were lighter.

The variant with the smallest average weight of the fruit is the one with treated roots (231 g), and the heaviest are the fruits of the variant with treated seeds + vegetation treatments (242 g).

When comparing the varieties with single treatments before planting, the seed-treated variety had a greater mean weight, although the fruits were on average 2 g lighter than those of the control. And of the variants with the vegetation treatment, the one with the largest fruit mass is again the one in which the seed treatment was also applied (TS+VT).

This indicates that it is likely that the treatment of seeds with Kelpak® leads to an increase in fruit mass.

Based on the realized harvests, it was found that almost all variants treated with Kelpak® gave lower yields in percentage ratio than the control (Figure 3). Only in the variant with only treated seeds, the yield in percentage terms is slightly higher than in the control, which is in confirmation of the results obtained from Warman and Munro-Warman (1993).

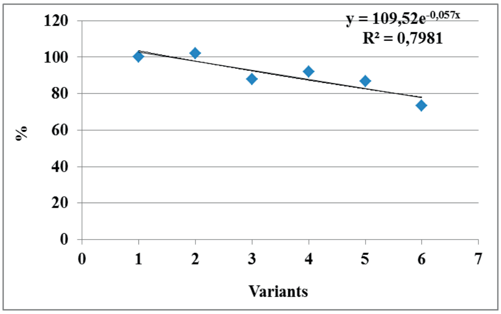

Figure 3. Yield of cucumbers in %

Although in the variant with treated seeds + vegetation treatments, the fruits are the heaviest, due to the smaller number of fruits, a low yield is also obtained. In the variant with only treated seeds, the fruits had a smaller mass than those of the control, but the greater number of fruits obtained in this variant led to higher yields compared to the control (Figure 3).

Based on the realized harvests, it can be concluded that the one-time treatment of only seeds leads to slightly higher yields.

CONCLUSIONS

Several conclusions can be drawn from the obtained results and the performed analyses:

A single treatment of the seeds, by soaking them without additional vegetation treatments with Kelpak® solution, leads to a better overall development of the plants. They are taller and have more leaves. Already at the first harvest, a larger number of fruits was obtained, and this trend was maintained until the last realized harvest.

When the treatment of the seeds was added to the treatment during the growing season by spraying the plants, there was a delay in their development. Despite the highest average weight of the fruits, affected by the delayed development and the small number of fruits, the lowest yield was obtained until the last realized harvest.

When treating the roots of the seedlings, there was a delay in the development of the plants, which also led to low yields.

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MISCELLANEOUS

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