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# The impact of foliar treatments on yield and quality of round pepper (*Capsicum annuum* L.) at *Asteroid 204 cv.*

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**ABSTRACT**

**The current climate trends and the reduced impact of biostimulants on the environment, agriculture and horticulture have increasingly oriented towards the use of biostimulants as part of the technologies applied to plants. This present study investigates the effects of different foliar treatments with calcium nitrate, used with or without biostimulants, on the yield and quality of round pepper fruits, Asteroid 204 cultivar, in order to use them in the culture technology of this species. Starting with the fruit set, four foliar treatments were applied in the field with an interval of 10 days between treatments. For treatments, calcium nitrate, the product Calcinit, was used alone or in combination with the biostimulants Kelpak or Triptolemus HV, the variants being as follows: V1 – no treatments applied, V2 – treated with calcium nitrate, V3 - treated with calcium nitrate and Kelpak, V4 - treated with calcium nitrate and Triptolemus HV. The plants were harvested at the technological and physiological maturity of the round pepper, which is the same for this variety of pepper. The applied treatments greatly influenced the yield and weight of the round pepper fruits, but had a lower influence regarding the quality of the fruits (total soluble solids and dry weight). The combination of calcium nitrate with biostimulants led to the highest yield increases in round pepper.**

**Keywords***:* calcium nitrate, *Ecklonia maxima*, foliar treatments, round pepper, *Trichoderma*

## INTRODUCTION

*Capsicum annuum* L. is popularly known as pepper and is part of the Solanaceae family, being one of the most important horticultural crops in the entire world. The genus *Capsicum* is distinguished by its generous content of vitamins A, B and C (Phillips *et al.*, 2006; Wahyuni *et al.*, 2011; Aminifard *et al.*, 2012) accompanied by a significant amount of minerals (iron, potassium, magnesium), as well as beta-carotene, folic acid and fibre. It also contains low amounts of omega-3 and omega-6 fatty acids (Nahida *et al.*, 2024).

Although *Capsicum annuum* L. has significant economic importance, the specialized literature provides limited information in this scientific area. In particular, regarding the fertilization needs of the pepper crop, there are few published studies analyzing the impact of alternative nutrient sources on their uptake in pepper plants, physiological performance and fruit quality. Agricultural management practices play an important role in the growth of this culture. Adequate sources of nitrogen improve plant growth and development, encourage flower development and improve pepper yield and quality (fruit size, color, taste) (Aminifard *et al.*, 2018; Shukla and Naik, 1993). *Capsicum* needs a significant amount of nitrogen, which contributes to the growth of the plant height, the number of lateral stems and the chlorophyll in leaves (Bhuvaneswari, 2014). Some studies indicate that a dose of 50 kg N/ha in field conditions is suitable for an optimal yield and a superior quality of mature fruits (Aminifard *et al.*, 2012). However, excessive use of nitrogen can have negative effects on plant growth, yield and fruit quality (Leghari *et al.*, 2016). Calcium is also a very important fertilizer for pepper crop, leading to an increase in yield and fruit quality, improving the content of macro and microelements (Buczkowska *et al.*, 2016). Furthermore, the lack of calcium can cause blossom end rot (Marcelis and Ho, 1999).

Nitrogen rates supplied as calcium nitrate should be used when multiple crops of bell peppers are expected (Simonne *et al.*, 1998). Periodic calcium sprays are recommended as an additional source of calcium, in addition to that present in the soil, to ensure that plants always receive a sufficient amount of calcium to meet their needs at all times (Geraldson, 1957). The application of amendments (inorganic and organic) significantly influences the fruit quality and photosynthetic rate of pepper plants (Chatzistathis *et al.*, 2022).

In recent times, agriculture has increasingly turned to the use of microorganism inoculum and seaweed extracts as part of a more sustainable and ecological approach. The most important effect that biostimulants with beneficial microorganisms have on plants is the antimicrobial action on diseases caused by bacteria or fungi (Drobek *et al.*, 2019). Biostimulants with *Trichoderma* can be combined with different types of fertilizers and can increase the production and quality of pepper fruits (Duan *et al.*, 2023).

The colonization of roots by *Trichoderma* strains favors pepper development, as well as the efficiency in the absorption of nutrients from the soil and organic matter, which leads to an increase in yield and increased resistance to abiotic and biotic factors. Also, can improve the soil microbiome in all stages of plant development (Toader *et al.*, 2022). It is estimated that the crop yield can increase by up to 30% following the treatment of seeds or soil with various species of *Trichoderma* (Benitez *et al.*, 2004). Although *Trichoderma* strains are generally used for soil treatments, some studies indicate the potential for their use as foliar treatments on pepper plants (Saxena *et al.*, 2016).

Seaweed extracts contain a variety of essential nutrients, amino acids, vitamins and growth hormones that can stimulate plant growth and development, properties known and used in agriculture and horticulture for a long time (Crouch and Van Staden, 1993; Battacharyya *et al.*, 2015). Seaweeds can be used both as a natural source of raw material and as a biofertilizer or stimulant for agricultural production, due to their high capacity to fix carbon dioxide and the nutrients they contain (Piwowar and Harasym, 2020). The most used species of macroalgae in agricultural production are brown seaweeds (Pereira, 2021), because they are richer than other macroalgae in macro and microelements, amino acids and essential vitamins for plant growth and development (Hong *et al.*, 2007). Previous studies show that pepper plants reacted well to seaweed treatments, leading to an increase in fruit yield (Salazar-Salazar *et al.*, 2022). However, there is little scientific experience regarding the use of seaweed on peppers, especially about fruit yield and quality. The aim of this study was to investigate foliar treatments with calcium nitrate, with or without added biostimulants, on the production and quality parameters of round pepper fruits.

## MATERIALS AND METHODS

The experience was carried out in the open field, within the Research and Development Institute for Vegetable and Flower Growing Vidra, Romania. The monofactorial experiment was placed according to the experimental technique, in randomized blocks, in three replications.

The biological material consisted of seedlings of the round pepper cultivar 'Asteroid 204', which the institute is the author and maintainer of. The seedlings were produced in the institute's greenhouses and were 55 days old when planted. The placement of the crop in the field was carried out on the 17th of May, 2024. The seedlings were planted on furrows mulched with black polyethylene film, with drip irrigation. The seedlings were placed in two rows per furrow, at a distance of 70 cm between rows and 24 cm between plants per row. The experimental factor consisted of the foliar treatments used. For these treatments, calcium nitrate (Calcinit product) was used alone, but also in combination with two biostimulant products: a biostimulator based on seaweed - Kelpak, and a biostimulant with a rich content of microorganisms - Triptolemus HV. The Calcinit product contains total nitrogen - 15.5 % and calcium oxide CaO 26.5 %. The Kelpak product is a pure extract of seaweed (*Ecklonia maxima*). The product Triptolemus HV contains mycorrhiza: 0.1%; rhizosphere bacteria: 1 x $10^5$ CFU $g^{-1}$ and *Trichoderma* spp.: 1.2 x $10^8$ CFU $g^{-1}$ (https://seminteplante.ro/8288-triptolemus-hv-inocul-de-trichoderma-lichid-1-litru.html?srsltid=AfmBOor8wHSHNxby6K3QK8BlHgHv5tVA7YRioikdrSQuoQHhokV4hIpt).

The experimental variants were: V1 = untreated foliar, V2 = foliar treatments with Calcinit (0.5%), V3 = foliar treatments with Calcinit (0.5%) + Kelpak (0.2%), V4 = foliar treatments with Calcinit (0.5%) + Triptolemus HV (0.3%). These were placed in three replications, resulting in 12 experimental plots, with an area of 13 $m^2$ each. A number of four foliar treatments were carried out, starting with the period when first fruit has reached typical size (BBCH 71). The treatments were applied in the following days: 15$^{th}$ of July (BBCH 71), 25$^{th}$ of July (BBCH 73), 4$^{th}$ of August (BBCH 74), 14$^{th}$ of August (BBCH 82).

The fruits were harvested at physiological maturity, with two harvests being carried out: on 2$^{nd}$ of September (BBCH 85) and 16$^{th}$ of September(BBCH 88). The fruits were weighed and counted, in order to determine the yield, the number of fruits per plant, and the average weight of a fruit. Fruits affected by blossom end rot were counted, in order to establish the percentage of affected fruits, depending on the treatments, but they were eliminated and were not used to calculate the production indices.

Laboratory analyzes included the measurement of average fruit weight and size indicators (fruit height and diameter), determination of total dry matter content, total dry soluble substance content and ash content. Each of these determinations was performed in three repetitions for each fertilization variant. Total dry matter content (DW) was expressed as a percentage (%). It was assessed by the gravimetric method, which consists of drying 10 g of fruit tissue at 105°C until constant weight was reached (Krełowska-Kułas, 1993).

Total soluble solids content (TSS) was determined with an Abbé refractometer and was expressed as °Brix (PN-90/A-75101/02). The ash content was determined by calcining the samples at 450°C for 48 hours and was expressed as a percentage of fresh weight (%FW) (AOAC, 2000).

The statistical analysis of all result data was conducted using SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± standard error (SE) and were evaluated using one-way analysis of variance (ANOVA). A significance level of $p < 0.05$ was used to determine statistically significant differences.

## RESULTS AND DISCUSSIONS

Table 1 presents measures of central tendency (mean, median) and measures of variability (standard deviation, coefficient of variation, minimum and maximum absolute variables) of the determined data.

As shown, yield per hectare recorded an average value of 40.57 t/ha, with a minimum of 31.33 t/ha and a maximum of 46.77 t/ha. The average weight of the fruit recorded a minimum value of 131.04 g and a maximum value of 173.98 g with an average of 163.17 ±

13.06 g. On average, pepper fruits had 8.34 ± 0.67% DW (spread between 6.80 and 7.80%), 7.33 ± 0.65°Brix (with 5.80 – 8.80°Brix). The average ash was 0.54 ± 0.06%FW (with 0.45 – 0.63%FW).

**Table 1.** Statistical descriptors (mean, median, std. deviation, coefficient of variation, minimum absolute, and maximum absolute) for fruit/plant, yield, fruits with blossom end rot, fruit weight, fruit height, fruit diameter, TSS, DW and ash content on *Capsicum annuum* L., 'Asteroid 204' cultivar

| | Fruits/ plant | Yield (t/ha) | Fruits with blossom end rot | Fruit weight (g) | Fruit height (mm) | Fruit diameter (mm) | TSS (°Brix) | DW (%) | Ash (% FW) |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 4.62 | 40.57 | 8.08 | 163.17 | 57.73 | 103.52 | 7.33 | 8.34 | 0.54 |
| Median | 4.63 | 41.29 | 7.50 | 168.00 | 56.53 | 104.01 | 7.40 | 8.39 | 0.56 |
| Std. Deviation | 0.31 | 4.99 | 3.40 | 13.06 | 4.16 | 6.64 | 0.65 | 0.67 | 0.06 |
| Var. Coeff. | 0.07 | 0.12 | 0.42 | 0.08 | 0.07 | 0.06 | 0.09 | 0.08 | 0.11 |
| Minimum | 4.16 | 31.33 | 2.00 | 131.04 | 46.90 | 92.21 | 5.80 | 7.44 | 0.45 |
| Maximum | 5.19 | 46.77 | 13.00 | 173.98 | 68.17 | 115.11 | 8.80 | 9.73 | 0.63 |

*TSS – total soluble solids in fruits; DW – dry weight of fruits; FW – fresh weight*
*Var. Coeff - Coefficient of variation is the ratio of the standard deviation to the mean (the closer the values are to 0, the more homogeneous the statistical series is, and the more representative the average becomes).*

Table 2 shows the influence of the foliar treatments used with calcium nitrate and biostimulants on some production indices. The number of fruits per plant increased significantly in the case of treatments with calcium nitrate in combination with Kelpak or Triptolemus HV products. In the case of the V3 variant, the number of fruits per plant increased by a percentage of 12.53%, and V4 led to an increase of 17.02%. The use of foliar treatments only with calcium nitrate was not sufficient for significant growth.

**Table 2.** Production parameters for pepper culture

| Variant | Treatments used | Fruits/plant | Yield (t/ha) | Fruits with blossom end rot (%) |
|---|---|---|---|---|
| V1 | untreated | 4.23±0.08[c] | 33.65±2.01[c] | 12.00±1.73[a] |
| V2 | calcium nitrate | 4.54±0.12[b] | 39.37±0.99[b] | 4.33±2.08[b] |
| V3 | calcium nitrate and Kelpak | 4.76±0.16[ab] | 45.25±2.30[a] | 6.33±1.15[b] |
| V4 | calcium nitrate and Triptolemus HV | 4.95±0.21[a] | 44.02±1.40[a] | 9.67±1.53[a] |

*Values followed by different letters within each column are significantly different based on the Duncan multiple range test (P≤0.05)*

Regarding fruit yield per hectare, it was significantly influenced by the treatments used. The yield increased both as a result of the increase in the number of fruits and as a result of the increase in the weight of the fruits. The highest yield was obtained in the case of the variant treated with calcium nitrate and Kelpak, which led to significant increases of 11.6 t/ha. The variant treated with calcium nitrate and Triptolemus HV also led to a similar increase in value, which led to an average increase of 10.37 t/ha. Treatments with simple calcium nitrate led to significant increases compared to the control variant, of 5.72 t/ha. Combining calcium nitrate with biostimulators led to a significant increase compared to the variant in which it was used simply. According to some studies, *Tricoderma* spp. colonizations induce an increase in yield (Duan *et al.*, 2023) by improving nutrient absorption, like nitrogen (Toader et al, 2022; Duan *et al.*, 2023).
The positive effect of using seaweed is explained by the content rich in macro and microelements, but also by the phytohormone-like activity that they prove (Battacharyya *et al.*, 2015). Previously, positive results were also obtained on pepper yield regarding the use of treatments with *Ecklonia maxima* (Arthur *et al.*, 2003). In addition to the auxin

activity, the studies also indicated a high and varied level of cytokinins in the extract of *Ecklonia maxima* (Stirk *et al.*, 2003). In the specialized literature, it is shown that there was a positive response also to other species of seaweed, such as *Ascophyllum nodosum*, which led to increases in pepper yield (Eris *et al.*, 1995).

The number of fruits affected by blossom end rot decreased significantly in the case of treatments with simple calcium nitrate or combined with Kelpak. Although decreases were also observed in the case of treatments with calcium nitrate and Triptolemus HV, they were not significant.

**Table 3.** Biophysical indices in pepper culture

| Variant | Treatments used | Fruit weight (g) | Fruit height (mm) | Fruit diameter (mm) |
|---|---|---|---|---|
| V1 | untreated | 143.33±4.79b | 50.99±4.017b | 95.54±3.15b |
| V2 | calcium nitrate | 170.67±3.51a | 60.33±4.713ab | 106.07±6.78a |
| V3 | calcium nitrate and Kelpak | 171.33±2.52a | 61.98±6.745a | 108.76±5.72a |
| V4 | calcium nitrate and Triptolemus HV | 167.33±1.53a | 57.62±4.38ab | 103.71±2.74ab |

*Values followed by different letters within each column are significantly different based on the Duncan multiple range test (P≤0.05)*

Table 3 shows the results obtained after the use of foliar treatments with calcium nitrate with or without biostimulants on some biometric indices in pepper fruits. With the increase in the number of fruits on plants, there is a risk of a decrease in the weight of the fruits. It is desired that the average fruit weight approaches the maximum value of the potential of the cultivar and fruits have high nutritional indices (Paran and Van der Knaap, 2007). The average weight (Table 3) of the fruits was significantly influenced by all the treatments used. The increases obtained after the foliar treatments had close values, varying between 24 g (in the case of variant V4) and 28 g (in the case of variant V3). This index was rather influenced by calcium nitrate than by the biostimulants used. The height and diameter of the fruits were significantly influenced by some variants of treatments. Combining calcium nitrate with Kelpak led to significant increases in both the height and diameter of fruit. The diameter of the fruits has also increased significantly in the case of the V2 variant (calcium nitrate). The increases determined by the treatments with calcium nitrate and Triptolemus HV (V4) were insufficient to be significant. Besides the size of the fruits, their quality is also defined by the nutritional properties, such as, for example, the total soluble solids, dry weight, and ash content (Moreno-Reséndez *et al.*, 2016).

Table 4 shows the influence of foliar treatments on quality indices of pepper fruits.

**Table 4.** Quality indices in pepper culture

| Variant | Treatments used | TSS (°Brix) | DW (%) | Ash (% FW) |
|---|---|---|---|---|
| V1 | untreated | 7.03±0.32$^{b}$ | 7.95±0.44$^{bc}$ | 0.52±0.03$^{b}$ |
| V2 | calcium nitrate | 7.33±0.06$^{ab}$ | 8.63±0.06$^{ab}$ | 0.58±0.02$^{a}$ |
| V3 | calcium nitrate and Kelpak | 7.47±0.06$^{a}$ | 9.13±0.54$^{a}$ | 0.60±0.04$^{a}$ |
| V4 | calcium nitrate and Triptolemus HV | 7.13±0.25$^{ab}$ | 7.66±0.19$^{c}$ | 0.48±0.03$^{b}$ |

**TSS – total soluble solids in fruits; DW – dry weight of fruits*
*Values followed by different letters within each column are significantly different based on the Duncan multiple range test (P≤0.05)*

Soluble solids, along with other phytochemical compounds, play an essential role in shaping fruit flavor. The total amount of these substances, which includes soluble sugars, soluble pectin, organic acids and various non-carbohydrate compounds, influences the refractive index of the aqueous fruit extract (Diaconu, 2006). This quality parameter plays an essential role, especially for fruits to be processed industrially (Stevens, 1972). All treatment variants led to increases in total soluble solids content, but significant differences were obtained only in the case of combining calcium nitrate with Kelpak (V3), which led to an increase of 6.26%.

The content of total soluble solids in pepper fruits increased significantly when treatments with calcium nitrate combined with the Kelpak product were applied. These treatments led to an increase of 5.95%. The increases caused by the use of treatments with calcium nitrate alone or combined with Triptolemus HV were not statistically assured.
The composition of dry matter comprises sugars, mainly carbohydrates (such as glucose and fructose, which constitute about 48% of the total sugars), lipids, proteins, minerals, vitamins, organic acids and phenolic compounds (Kader, 2002). DW in pepper fruits can be differentiated depending on ontogenetic and genetic factors (Niklis *et al.*, 2002), but also on agrotechnical factors (Yang *et al.*, 2012). DW increased significantly in the case of treatments with calcium nitrate used together with Kelpak product (V3), a combination that led to an increase of 14.84 %, from 7.95% to 9.13%. The increases determined by the V2 variant (calcium nitrate) were not statistically assured. Combining calcium nitrate with Triptolemus HV led to a slight, insignificant decrease in DW. The ash content highlights the presence of essential minerals, such as calcium, potassium, magnesium, phosphorous and others. The ash content of *Capsicum annuum* L. pepper cultivars is relatively high (Emmanuel – Ikpeme et al., 2014). The value of this variable increased significantly when calcium nitrate was applied alone (V2) or in combination with the Kelpak product (V3). Simple, it led to an increase of 11.53%, and combined with Kelpak, to an increase of

**Table 5.** The correlation matrix variant and fruits/plant, yield, fruit weight, fruit height, fruit diameter, total soluble solids, dry weight, and the ash content on *Capsicum annuum* L., 'Asteroid 204' cultivar

| | Variant | Fruits/ plant | Yield | Fruit weight | Fruit height | Fruit diameter | TSS | DW | Ash |
|---|---|---|---|---|---|---|---|---|---|
| Variant | 1 | 0.906** | 0.866** | 0.650* | 0.409 | 0.478 | 0.170 | 0.264 | 0.217 |
| Fruits/plant | | 1 | 0.762** | 0.688* | 0.374 | 0.569 | 0.018 | 0.019 | -0.167 |
| Yield | | | 1 | 0.727** | 0.499 | 0.569 | 0.403 | 0.403 | 0.163 |
| Fruit weight | | | | 1 | 0.784** | 0.840** | 0.556 | 0.367 | 0.306 |
| Fruit height | | | | | 1 | 0.867** | 0.740** | 0.224 | 0.550 |
| Fruit diameter | | | | | | 1 | 0.584* | 0.350 | 0.465 |
| TSS | | | | | | | 1 | 0.346 | 0.494 |
| DW | | | | | | | | 1 | 0.735** |
| Ash | | | | | | | | | 1 |

*TSS – total soluble solids in fruits; DW – dry weight of fruits; ** - correlation is significant at the 0.01 level*
** - Correlation is significant at the 0.05 level*

According to table 5, there was a distinctly significant positive correlation between the fertilization variant and the amount of fruit per plant (r=0.906**) and yield (r=0.866**), and significant for the production (r=0.650*). These results indicate that the plant assimilated the nutrients from the treatments, leading to an increase in productivity and less in the improvement of fruit quality in the year 2024, although can be observed a tendency to increase TSS, DW or ash content following the fertilizations carried out, a positive but insignificant correlation. This aspect was also suggested by a positive, distinctly significant correlation between fruit yield and number of fruits per plant (r=0.762**), or between production and fruit weight (r=0.727**). The yield of the round pepper crop was influenced by the number of fruits per plant. A similar positive and distinct significant correlation was established between ash content and DW (r=0,735**).

## CONCLUSIONS

Treatments with calcium nitrate with or without biostimulants lead to increases in yield in round peppers. Also, fruits weight was positively influenced by the treatments with fertilizing potential used in the present study.

Calcium nitrate and its combination with Kelpak leads to a significant decrease in the number of fruits affected by blossom end rot and increase the quality of fruits, improving total soluble solids, DW and ash content.

In practice, combining calcium nitrate with biostimulants increases the potential of treatments, leading to higher yields. Combining calcium nitrate with the Kelpak product also led to an increase in fruit quality.

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## REFERENCES

1. Aminifard M. H., Aroiee H., Ameri A., and Fatemi H. (2012). Effect of plant density and nitrogen fertilizer on growth, yield and fruit quality of sweet pepper (*Capsicum annum* L.). African Journal of Agricultural Research, 7(6), 859-866.
2. Aminifard. M. H., and Bayat. H. (2018). Influence of different rates of nitrogen fertilizer on growth, yield and fruit quality of sweet pepper (*Capsicum annum* L. var. California Wander). Journal of Horticulture and Postharvest Research, 1(2), 105-114.
3. Battacharyya D., Babgohari. M.Z., Rathor. P. and Prithiviraj. B. (2015). Seaweed extracts as biostimulants in horticulture. Sci. Hortic, 196, 39-48
4. Benítez T., Rincón.A. M., Limón M. C. and Codon A. C. (2004). Biocontrol mechanisms of *Trichoderma* strains. International microbiology, 7(4), 249-260.
5. Bhuvaneswari G., Sivaranjani. R., Reetha S. and Ramakrishan K. (2014). Application of nitrogen fertilizer on plant density, growth, yield and fruit of bell peppers (*Capsicum annuum* L.). International Letters of Natural Sciences, 8(2).
6. Buczkowska H., Michałojć. Z. and Nurzyńska-Wierdak R. (2016). Yield and fruit quality of sweet pepper depending on foliar application of calcium. Turk. J. Agric. For, 40(2), 222-228
7. Chatzistathis T., Tsaniklidis. G., Papaioannou A., Giannakoula A. and Koukounaras A. (2022). Comparative approach on the effects of soil amendments and controlled-release fertilizer application on the growth, nutrient uptake, physiological performance and fruit quality of pepper (*Capsicum annuum* L.) plants. Agronomy, 12(8), 1935.
8. Crouch I. J. and Van Staden J. (1993). Evidence for the presence of plant growth regulators in commercial seaweed products. Plant growth regul., 13, 21-29
9. Diacon.u C. (2006). Valoarea biologică și culturală a germoplasmei de căpșun (*Fragaria x ananassa*) și utilitatea ei în programele de ameliorare genetică. Phd Thesis, ASAS Bucharest (in Romanian).
10. Drobek M., Frąc M. and Cybulska J. (2019). Plant biostimulants: Importance of the quality and yield of horticultural crops and the improvement of plant tolerance to abiotic stress—A review. Agronomy, 9(6), article 335
11. Duan X., Zou. C., Jiang Y., Yu X. and Ye X. (2023). Effects of Reduced Phosphate Fertilizer and Increased Trichoderma Application on the Growth, Yield, and Quality of Pepper. Plants, 12(16), 2998.
12. Emmanuel-Ikpeme C., Henry P. and Okiri O. A. (2014). Comparative evaluation of the nutritional phytochemical and microbiological quality of three pepper varieties. Journal of food and nutrition sciences, 2 (3), 74-80.
13. Eris A., Sivritepe H. Ö. and Sivritepe N. (1995). The effect of seaweed (*Ascophyllum nodosum*) extract on yield and quality criteria in peppers. Acta Horticulturae, 412, 185-192
14. Geraldson C. M. (1957). Factors affecting calcium nutrition of celery, tomato, and pepper. Soil Science Society of America Journal, 21(6), 621-625.

16. Hong D. D., Hien H. M. and Son P. N. (2007). Seaweeds from Vietnam used for functional food, medicine and biofertilizer. Journal of Applied Phycology, 19, 817-826.
17. Kader A.A., 2002. Fruits in the global market, In Knee, M., (Ed). Fruit quality and its biological basis, Sheffield Academic Press, UK, 1-16.
18. Krełowska-Kułas M., 1993. Badanie jakości produktów spożywczych. PWE, Warszawa. [In Polish]
19. Leghari S. J., Wahocho N. A., Laghari G. M., Hafeez Laghari A., Mustafa Bhabhan G. and Hussain Talpur K. (2016). Role of nitrogen for plant growth and development: A review. Advances in Environmental Biology, 10(9), 209-219.
20. Marcelis L. F. M. and Ho, L. C. (1999). Blossom-end rot in relation to growth rate and calcium content in fruits of sweet pepper (*Capsicum annuum* L.). J. Exp. Bot., 50(332), 357-363
21. Moreno-Reséndez A., Parcero-Solano R., Reyes-Carrillo J. L., Salas-Pérez L., del Rosario Moncayo-Luján M., Ramírez-Aragón M. G. and Rodríguez-Dimas N. (2016). Organic manures improved the phenolic content, antioxidant capacity and soluble solids in pepper. Food and Nutrition Sciences, 7(14), 1401.
22. Nahida N., Khan S. A. K. U., Díaz-Pérez J. C. and Kabir M. Y. (2024). Plant growth, fruit yield, and quality of capsicum (*Capsicum annum* L.) as affected by nitrogen levels in the coastal soil of Bangladesh. Khulna University Studies, 187-194.
23. Niklis N.D., Siomos A.S., Sfakiotakis E. M. (2002). Ascorbic acid, soluble solids and dry matter content in sweet pepper fruit: change during ripening. J. Veg. Crop. Prod, 8, 41-51.
24. Paran I. and Van Der Knaap E. (2007). Genetic and molecular regulation of fruit and plant domestication traits in tomato and pepper. Journal of experimental botany, 58(14), 3841-3852.
25. Pereira L. (2021). Macroalgae. Encyclopedia, 1(1), 177–188.
26. Phillips K. M., Ruggio D. M., Ashraf-Khorassani M. and Haytowitz D. B. (2006). Difference in folate content of green and red sweet peppers (*Capsicum annuum*) determined by liquid chromatography– mass spectrometry. Journal of agricultural and food chemistry, 54(26), 9998-10002.
27. Piwowar A. and Harasym J. (2020). The importance and prospects of the use of algae in agribusiness. Sustainability, 12(14), 5669.
28. Salazar-Salazar W., Monge-Pérez J. E. and Loría-Coto M. (2022). Foliar spray of seaweed extract and fertilizers on sweet pepper (*Capsicum annuum*). Cuadernos de Investigación UNED, 14(2), 149-161.
29. Saxena A., Raghuwanshi R. and Singh H. B. (2016). Elevation of defense network in chilli against *Colletotrichum capsici* by phyllospheric *Trichoderma* strain. Journal of Plant Growth Regulation, 35, 377-389
30. Shukla V. and Naik L. B. (1993). Agro-techniques for solanaceous vegetables. Advances in horticulture. 5: 365-399, Malhotra Publishing House, New Delhi, India.
31. Simonne E. H., Eakes D. J. and Harris C. E. (1998). Effects of irrigation and nitrogen rates on foliar mineral composition of bell pepper. Journal of plant nutrition, 21(12), 2545-2555.
32. Stevens M. A. (1972). Citrate and malate concentrations in tomato fruits: genetic control and maturational effects. Journal of the American Society for Horticultural Science 97, 655-658.
33. Stirk W. A., Novák O., Strnad M. and Van Staden J. (2003). Cytokinins in macroalgae. Plant growth regul., 41, 13-24.
34. Toader C. A., Burnichi F., Tom D. M., Manea V., Mirea E. and Popa M. E. (2022). Evaluation of the impact of the *Trichoderma* treatment in Buzău bell pepper (*Capsicum annuum*) culture 10. Scientific Bulletin, Series F- Biotechnologies, XXVI (2), 47-51.
35. Wahyuni Y., Ballester A. R., Sudarmonowati E., Bino R. J. and Bovy A. G. (2011). Metabolite biodiversity in pepper (*Capsicum*) fruits of thirty-two diverse accessions: Variation in health-related compounds and implications for breeding. Phytochemistry 72(11-12), 1358-1370.
36. Yang Z., Zhao X., Su T., Zhou Z., Zhu K., Peng X. (2012). Effects of light quality on dry matter production and partitioning index of greenhouse sweet pepper. Chinese J Ecol, 31, 1117-1122.
37. Horwitz W. (2000). Official methods of analysis of AOAC International (17th ed). Association of Official Analytical Chemists, Gaithersburg, MD, USA
38. PN-90/A-75101/04. 1990. Przetwory owocowe i warzywne. Przygotowanie próbek i metody badań fizykochemicznych. Oznaczanie zawartości suchej masy metodą wagową [Fruit products and vegetable. The preparation of samples and method of physicochemist investigations.Marking the content of dry mass with weight method]. PKN, MiJ Warszawa
39. Seminte plante. (2024). *Triptolemus HV, inocul de Trichoderma lichid, 1 litru*. https://seminteplante.ro/8288-triptolemus-hv-inocul-de-trichoderma-lichid-1-litru.html?srsltid=AfmBOor8wHSHNxby6K3QK8BlHgHv5tVA7YRioikdrSQuoQHhokV4hIpt