PRELIMINARY RESULTS ON GROWING EARLY CABBAGE IN ORGANIC SYSTEM

REZULTATE PRELIMINARII PRIVIND CULTURA VERZEI TIMPURII ÎN SISTEM ECOLOGIC

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Abstract.
Cabbage is one of the most important vegetable crops in the world for its resilience. Cabbage crops require soils with a pH between 6 and 7.5. If necessary, amendments are used to correct soil acidity. Organic and inorganic fertilizers provide nutrients available to cabbage plants for proper vegetative growth. It has been found that nitrates accumulate predominantly in the outer leaves rather than in the head. The method of obtaining the biostimulant has different effects on nitrate content. Thus, in most cases, biostimulants obtained through mechanical homogenization decreased the nitrate content in the leaves but increased the nitrate content in the head; biostimulants obtained using ultrasound had the opposite effect, namely increasing nitrate content in the leaves but decreasing it in the head. The results obtained regarding the influence of herbal biostimulants on the content of microelements and macroelements will be presented.
Key words: early cabbage, nutrients, cultivars.

Rezumat.
Cultura de varză este una dintre cele mai importante culturi legumicole la nivel mondial, datorită rezilienței ridicate. Cultura de varză necesită soluri cu pH cuprins între 6 și 7,5. Dacă este necesar, se folosesc amendamente pentru corecția acidității solului. Îngrășămintele organice și cele anorganice furnizează nutrienți disponibili pentru plantele de varză pentru o creștere vegetativă adecvată. S-a constatat că nitrații s-au acumulat preponderent în frunzele exterioare decât în căpățână. Modul de obținere a biostimulantului are efecte diferite asupra conținutului de nitrați. Astfel, în majoritatea cazurilor, biostimulanții obținuți prin omogenizare mecanică au scăzut conținutul de nitrați în frunze, dar au crescut conținutul de nitrați în căpățână; biostimulanții obținuți cu ajutorul ultrasunetelor au avut un efect opus, adică au crescut conținutul de nitrați în frunze, dar au scăzut conținutul de nitrați în căpățână. Se vor prezenta rezultatele obținute privind influența utilizării unor biostimulanți pe bază de plante asupra conținutului de microelemente și macroelemente.
Cuvinte cheie: varza timpurie, nutrienți, cultivare.

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INTRODUCTION

Cabbage is one of the important vegetables, being cultivated worldwide. It is part of the Cruciferae family, which also includes, among others, broccoli, cauliflower, and Brussels sprouts. It can be consumed raw, cooked, or pickled. Over time, it has been used both as food and for therapeutic purposes (in rural areas, even today, poultices made from cabbage leaves are used for wounds or minor burns) [Ștefan and Ona, 2020].

The food value of cabbage can be evaluated by nutritional value and sensory quality. Innocuousness is the absence or presence within safe limits of harmful substances and contaminants for humans [Goran, 2014]. This is one of the qualitative components of cabbage.

Nutritive value can be assessed by the amount of nutrients present that ensure the proper functioning of metabolic processes in the body. It depends on the variety or hybrid, the way of cultivation, the season and the elements in the cultivation technology [Dobrotă, 2010].

Mineral nutrition in plants involves the physiological process of mineral substance absorption from the environment for the synthesis of complex organic substances essential for proper developmental processes within the plant organism [Jităreanu and Marta, 2019]. If a necessary chemical element is lacking or insufficient in plant nutrition, physiological diseases occur, with multiple symptomatic manifestations. An excess of one or more elements can become toxic to the plant, while inadequate amounts lead to deficiency symptoms.

The nutrients necessary for the growth and development of cabbage plants are mostly found in the soil. The supply of nutrients to plants is closely related to their presence in the soil, soil temperature, moisture, photosynthesis, respiration, and soil pH. The degree of solubilization and dissociation of these nutrients into forms that can be absorbed by plants is crucial.

Soil fertilization is carried out to ensure that the necessary quantities of nutrients are present in the soil; this fertilization can be carried out with synthetic chemicals (in intensive farming) or with chemicals obtained from natural fertilizers (in organic farming).

It has been confirmed that the exclusive and unbalanced use of mineral fertilizers continuously leads to a decrease in the efficiency of nutrient absorption by plants, resulting in either stagnation of production or reduction of yield [Negi *et al.*, 2017]. At the same time, prolonged use of intensive agriculture makes the transition to organic farming much more difficult and takes a longer period of time. Thus, even five years after conversion, residues of organochlorine pesticides (OCP) have been detected in soil samples [Stoleru *et al.*, 2016].

Biofertilizers offer an economically advantageous and environmentally sustainable alternative for reducing external inputs and improving both the quality and quantity of vegetable production. They contain microorganisms capable of mobilizing nutrients, transforming them from an inaccessible form into an available form through various biological processes [Negi *et al.*, 2017].

For a food product to be considered safe, it is necessary to understand the risk factors throughout the entire technological chain, from raw materials to the final product. These risk factors can be internal or external, and their identification helps minimize negative effects on product quality and, consequently, on human health [Rusu *et al.*, 2025].

All agricultural crops, including cabbage crops, are constantly subjected to pest attacks. Various experiments have concluded that there is a close relationship between the cultivar and pest control methods [Stoleru *et al.*, 2012].

Cabbage crops require soils with a pH between 6 and 7.5. In practice, not all soils meet this condition. In such cases, soil amendments are used to correct soil acidity, one of which is biochar. Biochar can be produced through the slow pyrolysis of biomass residues.

Applying biochar on marginal agricultural soils enhances soil quality, positively influences plant growth and production, and minimizes biomass residues. Due to its porous structure, biochar possesses a significant capacity for water absorption and retention in the soil.

Biochar can enhance soil structure, increase porosity, elevate pH value, improve water holding capacity (WHC), boost cation exchange capacity (CEC), enhance nutrient retention capacity, and increase organic carbon concentration, available phosphorus concentration, and total carbon and nitrogen. Additionally, it contributes to a reduction in soil bulk density (BD), nutrient loss, and heavy metal bioavailability. Furthermore, it can inhibit pathogens in the soil and promote the growth and activity of beneficial microbial populations, as well as increase the activity of soil enzymes.

These positive effects of biochar on soil physico-chemical and biological properties increase nutrient availability to plants, which generally leads to improved crop performance. Several studies have shown that biochar applied in combination with inorganic or organic fertilizers improved soil fertility and plant performance. Increased soil fertility results in reduced fertilizer input as well as higher crop productivity and therefore additional CO_2 consumption, leading to agronomic, environmental and economic benefits.

The effects of biochar on the soil-plant system are influenced by several factors, including the physico-chemical properties and dosage of biochar, the type and dosage of fertilizer, plant species, soil characteristics, and climate conditions. The physicochemical properties of biochar are determined by the type and pre-treatment of the raw material, as well as the pyrolysis conditions and post-pyrolytic treatments. Biochar produced at higher temperatures typically exhibits greater alkalinity, higher water holding capacity, increased fixed carbon and ash concentrations, enhanced aromaticity, fewer surface functional groups, and lower cation exchange capacity compared to biochar produced at lower temperatures. The agronomic benefits of biochar amendment are most pronounced in sandy soils, followed by sandy-clay soils, and subsequently in saline soils, with a greater impact observed in acidic soils as opposed to neutral and alkaline soils.

The extremely slow decomposition of the biochar itself is favourable to humus formation and contributes to the improvement of soil fertility through long-term action. Additionally, biochar can alter the form of toxic elements, reduce pollution during plant growth, promote the absorption of nutrients, and stimulate plant growth [Calcan *et al.*, 2022].

It should be noted that, although they belong to the same species, different cabbage varieties have different phytochemical composition; for this purpose, white cabbage (*Brassica oleraceae* var. *capitata* f. *alba*), red cabbage (*Brassica oleraceae* var. *capitata* f. *rubra*), conical cabbage (*Brassica oleraceae* var. *capitata* f. *acuta*) and Savoy cabbage (*Brassica oleraceae* var. *capitata* f. *sabauda*) were compared. Red cabbage is an important source of phenolic compounds (especially anthocyanins), while white cabbage has the highest concentration of glucosinolates. Conical cabbage contains both glucosinolates and has a more consistent phytochemical composition [Statilko *et al.*, 2024].

Several plants from the *Brassicaceae* family were analyzed to compare the concentration of phenolic compounds, glucosinolates, proteins, sugars and vitamin C, as well as their antioxidant potential. The studied plants included kohlrabi (*Brassica oleracea* var. *acephala gongylodes*), Savoy cabbage (*B. oleracea sabauda*), Brussels sprouts (*B. oleracea gemmifera*), cauliflower (*B. oleracea botrytis*), radish (*Raphanus sativus*), and garden cress (*Lepidium sativum*).

The study found that kohlrabi had the highest concentration of phenolic compounds, while Savoy cabbage and Brussels sprouts exhibited the highest levels of glucosinolates. Garden cress had the lowest content of soluble sugars. The protein content showed insignificant variation among the studied plants, while radish had the highest vitamin C content. Additionally, plants from the *Brassica* genus demonstrated significantly higher antioxidant capacity than radish and garden cress [Šola *et al.*, 2024].

MATERIAL AND METHOD

A single variety of cabbage was cultivated in sandy loam soil with a pH of 7.4, characterized by low levels of organic carbon, nitrogen, and potassium, and high phosphorus content. The distance between transplanted seedlings was 45x45 cm. The nutrient rates were noted as S_1 (recommended rate of NPK 120-60-60 kg/ha), S_2 (20 t/ha of manure) and S_3 (half the recommended rate of NPK 120-60-60-60 kg/ha + 10 t/ha of manure). These nutrition prescriptions were associated with the use of a biofertilizer (phosphate-solubilizing bacteria), denoted B_0 (without biofertilizer application) and B_1 (with biofertilizer application).

The three nutritional treatments were applied three times, while the biofertilizer was applied only once, at the time of transplanting.

Data were collected on the morphological characteristics of the cabbage plants, including plant height, head weight, and head diameter, as well as the productive potential, evaluated in terms of production per hectare.

RESULTS AND DISCUSSIONS

The following results were obtained.

a. Plant height

Plant height was measured at 30, 45 and 60 days after transplanting and the results obtained are presented in Table 1.

Table 1

The effect of different nutritional treatments on cabbage plant height

Days after transplanting	Biofertilizer application	Nutrition treatments		
		S_1	S_2	S_3
30	B_0	15.33	14.90	15.87
	B_1	15.80	15.33	16.40
45	B_0	25.20	26.87	29.27
	B_1	27.16	28.67	30.00
60	B_0	30.00	31.80	36.53
	B_1	33.40	37.27	37.20

The best response in terms of cabbage plant height was observed with the combined nutrition of NPK fertilizer and manure (S_3 treatment). Although initially, the NPK fertilizer treatment (S_1) promoted plant growth, it ultimately proved to be the least beneficial. The application of a biofertilizer had a positive effect on plant height during all growth stages, with the strongest effect occurring during the head development phase. These results are graphically represented in Figure 1.

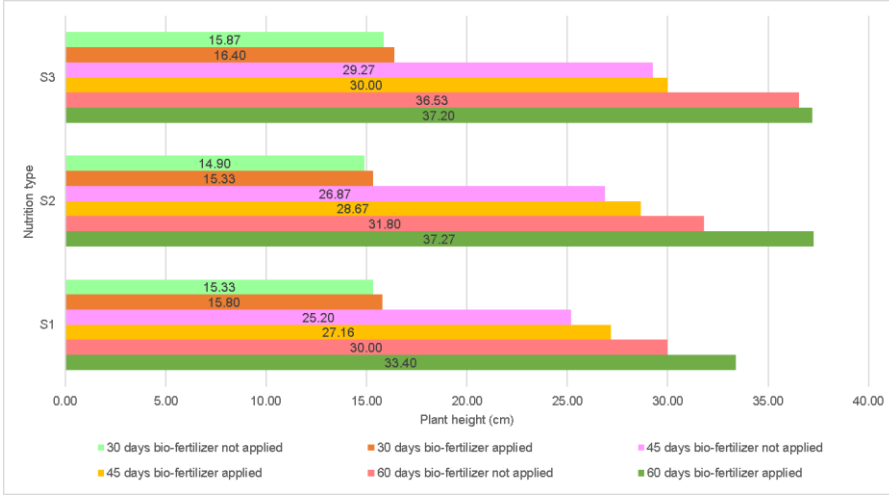

Fig. 1. Graphical representation of nutrition results on cabbage plant height

b. Head diameter

The results regarding the effect of nutrition on the diameter of cabbage heads are presented in Table 2.

Table 2

Effect of nutritional treatments on the diameter of cabbage heads

	Biofertilizer application	Nutrition treatments		
		S_1	S_2	S_3
Head diameter (mm)	B_0	152.40	131.33	175.80
	B_1	170.70	141.00	189.43

There are quite large differences in head size depending on the nutritional treatment. Once again, the largest heads were obtained with the combined nutrition of NPK fertilizer and manure (S_3 treatment). The application of a biofertilizer had a positive effect on head size, with heads being up to 12% larger (S_1 treatment).

These results are graphically presented in Figure 2.

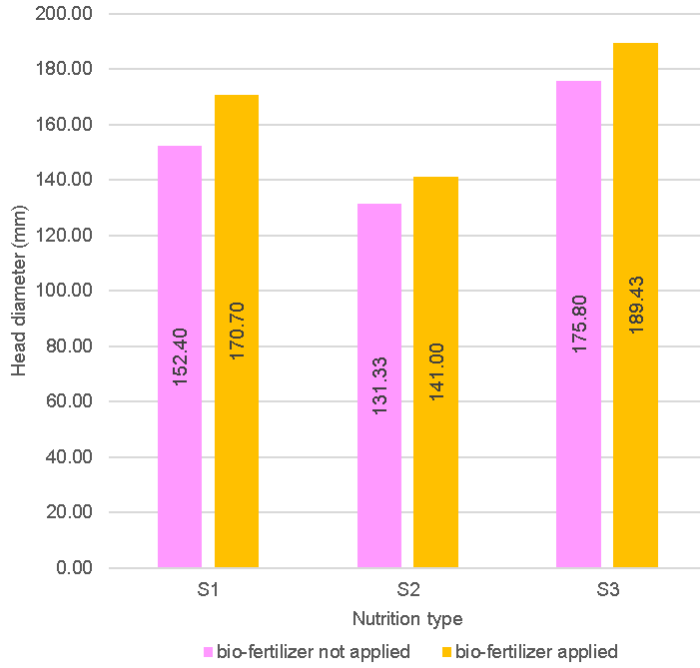

Fig. 2. Graphical representation of the results regarding the effect of nutrition on cabbage head diameter

c. Head weight and cabbage yield

The results obtained on the effect of nutrition on head weight and cabbage yield are presented in Table 3.

Table 3

Effect of nutritional treatments on cabbage head weight and yield

	Biofertilizer application	Nutrition treatments		
		S_1	S_2	S_3
Head weight (g)	B_0	2260.67	2438.33	2407.33
	B_1	2389.67	2511.67	2716.33
Yield (kg/Ha)	B_0	34,293	41,397	46,480
	B_1	37,551	44,173	54,330

It is observed that the nutrition formulas have resulted in obtaining heavier heads and higher yields when combined with biofertilizer, compared to when they were applied alone.

Graphically, these results are presented in Figure 3.

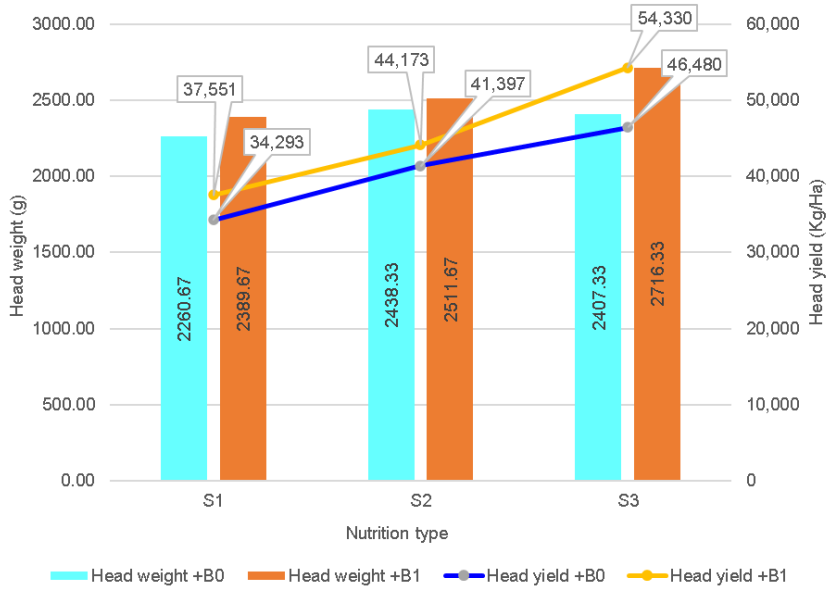

Fig. 3. Graphical representation of the results regarding the effect of nutrition on cabbage head weight and yield

Cabbage crops require fertile soil and their development is influenced by the soil profile. Hard layers, clay layers, and compacted soil generally restrict root growth. This, in turn, leads to reduced nutrient and water absorption, ultimately limiting plant growth and yield (Hossain et al., 2015).

CONCLUSIONS

The good results were achieved using the S_3 recipe, which comprised half of the recommended NPK dose of 120-60-60 kg/ha combined with 10 t/ha of manure.

This result can be attributed to the synergistic effects of organic and inorganic fertilizers, which supplied essential nutrients to the cabbage plants, facilitating adequate vegetative growth. Additionally, the introduction of biofertilizers, specifically phosphate solubilizing bacteria, enhanced phosphorus availability to the plants. The application of manure improved water holding capacity, micronutrient supply, and the availability of primary nutrients, thereby creating favourable soil conditions. These beneficial effects of manure have also been observed in broccoli crops (Mal et al., 2015).

REFERENCES

1. **Calcan S.I., Pârvulescu O.C., Ion V.A., Răducanu C.E.; Bădulescu L., Madjar R., Dobre T., Egri D.; Moț A., Iliescu L.M., Jerca I.O., 2022** - *Effects of biochar on soil properties and tomato growth*. Agronomy 12(8), 1824.
2. **Hossain, M.F., Farhana, T., Raihan, M.Z., Hasan, M.S., Mia, M.M., & Rahman, M.M., 2015** - *Effect of different fertilization practices on the growth and yield of cabbage*. Asian Journal of Medical and Biological Research, 1(2), 182–186. https://doi.org/10.3329/ajmbr.v1i2.25610
3. **Jităreanu C.D., Marta A.E., 2019** - *Fiziologia plantelor*, Ed. Ion Ionescu de la Brad, Iași.
4. **Mal D., Chatterjee R., Nimbalkar K.H., 2015** - *Effect of vermi-compost and inorganic fertilizers on growth, yield and quality of sprouting broccoli (Brassica Oleracea L. Var. Italica Plenck).* International Journal of Bio-Resource and Stress Management; 5(4):507-512.
5. **Rusu O.R., G.C. Teliban, A. Borș, V.C. Florișteanu, Gh. Vlad, A. Cojocaru, M. Roșca and V. Stoleru, 2025** - *Possibilities of implementing the HACCP plan for tomato crop*. Acta Horticulturae no. 1416, 501-508. Proceedings of the International Symposium on Sustainable Vegetable Production from Seed to Health Booster Sources ISBN-978-94-6261-415-4.
6. **Šola I., Vujčić Bok V., Popović M., Gagić S., 2024** - *Phytochemical composition and functional properties of brassicaceae microgreens: impact of in vitro digestion*. Int. J. Mol. Sci, 25, 11831. https://doi.org/10.3390/ijms252111831
7. **Statilko O.; Tsiaka T.; Sinanoglou V.J.; Strati I.F., 2024** - *Overview of phytochemical composition of Brassica oleraceae var. capitata cultivars*. Foods, 13, 3395. https://doi.org/10.3390/foods13213395
8. **Ștefan I.M.A., Ona A., 2020** - *Cabbage (Brassica oleracea L.). Overview of the health benefits and therapeutical uses.* Hop and Medicinal Plants, Year XXVIII, No. 1-2, ISSN 2360–0179 print, ISSN 2360–0187 electronic.
9. **Stoleru V., Munteanu N., Hura C., Sellitto V.M., Gavrilescu M., 2016** - *Organochlorine pesticide residues in soil and edible vegetable.* Environmental Engineering and Management Journal. 15(3): 527-535. 10.30638/eemj.2016.057
10. **Stoleru V., Munteanu N., Stoleru C.M., Rotaru L., 2012** - *Cultivar selection and pest control techniques on organic white cabbage yield*. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, *40*(2), 190–196. https://doi.org/10.15835/nbha4027993