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Impact of green technology on content of bioactive components in eggplant

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ABSTRACT

Background: Green manure fertilizers play a great role in increasing fertility, soil quality and nutrient supply of crops. Additionally, biofertilizers with various strains of fungi increase the availability of biologically active elements for plants. The combined use of green manure and biological fertilizers is of great interest for increasing the content of bioactive components and the functional activity of food.

Objective: The main goal of the research was to evaluate the effectiveness of the combined use of various green manure plants and biological fertilizers on the content of bioactive components (total sugars, dry matter, ascorbic acid, B vitamins and macro and micronutrients) in eggplants in the context of increasing food functionality.

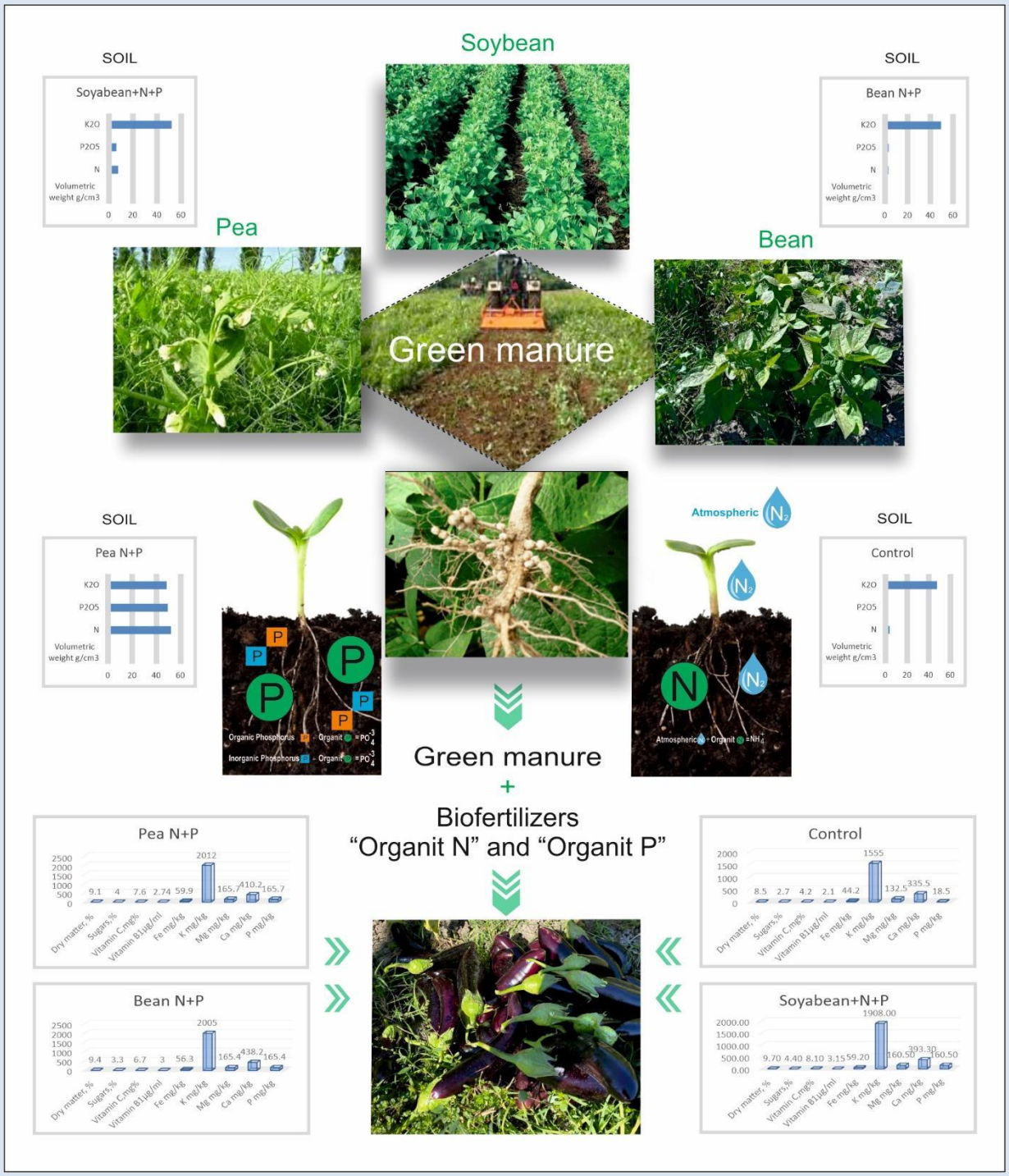
Methods: Plants from the Fabaceae L. family (beans, peas, and soybeans) were used as green manure. The experiment was set up by a block-randomized method in 4 replications. Biofertilizers were applied at the beginning of intensive growth and at the beginning of the fruiting stage. Soil analysis and content of macro- and micronutrients (Potassium, Calcium, Magnesium, Phosphate, and Iron) in eggplant fruits were done with a spectrophotometry system.

Results: Green manure crops and their combination with biofertilizers contributed to an increase in content of

vitamin C, Vitamin B_1, macro-micronutrients (calcium, potassium, phosphorus, magnesium, and Iron) in all treatment options. The higher yield was recorded in variants with the use of Organit N' and 'Organit P'.

Conclusion: The concurrent application of green manure and biofertilizers leads to an enhancement of the functional properties of eggplant fruits. This improvement is attributed to the enhanced soil quality and increased levels of nutrients and bioactive compounds, including vitamins C and B1.The positive effect of the applied technology on the eggplant fruits' qualitative particularities, productivity and functionality creates a basis for recommending the use of tested fertilizers to producers and will serve as a starting point for evaluating the proposed green technology on other crops.

Keywords: soya, bean, pea, vitamin C, vitamin B 1



INTRODUCTION

Eggplant (*Solanum melongena* L.) is a plant species belonging to the Solanaceae L. family and is one of the important food crops in Armenia, with a planted area of 1,533 hectares in 2022, accounting for 8.6% of the total area under vegetable crops [1]. The interest in this crop is due to its nutritional value and the traditions of national cuisine. In the technical ripeness phase, eggplant fruits contain sugar, starch, pectin, organic acids, vitamins C, B1, B2, B6, B5, PP, carotene, macro and microelements and essential amino acids [2-4]. Because of this, eggplants are recommended as a dietary food for cardiovascular diseases for the prevention of cancer or diseases of the gastrointestinal system [5-9].

The health benefits and human immune response, conditioned by the content of bioactive compounds and their valuable features [10], which, in turn, play an important role in enhancing food functionality, depend on several factors [11-13].The way the fruit is used and how it is processed (raw, cooked, frozen), is one of the factors to be considered in estimating functionally [14] of different crops including eggplants. Other factors include the genotypes of the plants [16-17], the environmental conditions of growing [18] and cultivation technologies [19-21], mainly in terms of fertilization, which significantly affect the content of bioactive elements [22]. Considering the modern trends and customers' demand for eco-friendly farming production, agricultural systems targeted at improved fruit quality and increased resilience are being promoted. Therefore, it is very important to produce healthy and highly functional eggplant fruits, avoiding the application of pesticides and mineral fertilizers. The high efficiency of green manure and biological fertilizers in increasing soil fertility and nutrient supply of crops, noted in numerous studies conducted on different crops [23-27]. This allows us to judge the direct correlation between the use of green manure with biological fertilizers and increasing the content of bioactive elements in crop fruits [28-29]. Among green manure crops, legumes are a higher-ranking green manure crop compared to non-legume crops due to their ability to fix atmospheric nitrogen. Considering that legume-based green manures are used with the purpose to increase nitrogen content in the soil. The findings of many scientists suggest that green manure incorporation is an effective practice and provides substantial benefits to the soil–plant system [30].

Benefits of green manuring can be increased with additional use of organic, biological, or other fertilizers [31-32]. Green manure and biological fertilizers improve soil structure, increase water-holding capacity, and enhance microbial activity in the soil, reduce chemical residues, increase environmental sustainability, and create a basis for the increase of crops antioxidant activity [33-36]. As a result, the vegetables grown in such soil conditions tend to have higher nutrient content compared to those grown in conventional systems. Increased levels of vitamins, minerals, and antioxidants in the fruits can contribute to their enhanced food functionality [37]. This can lead to safer and more importantly healthier food products for consumers [38-39].

The content of various strains of fungi in biofertilizers promotes the absorption of many biologically active elements by plants, such as Nitrogen, Phosphorus, Potassium, and many vitamins [40-41]. In our experiments locally produced biofertilizers, ‘Organic N’ and ‘Organic P’, were tested and were found to contain Azospirillum zeae sp. Nov.,a diazotrophic bacterium isolated from the rhizosphere soil of *Zea mays* and Bacillus megaterium strains [42]. The Azospirillum strain is known for its properties to increase green biomass of plants and fruits. Research conducted on certain ornamental plants, such as Delonix regia, reveals that treating seedlings with a bioinoculant containing the Azospirillum strain alone or in various combinations with other strains, in conjunction with mycorrhiza fungi, proves beneficial for enhancing plant growth. This treatment results in increased nitrogen yield, protein and chlorophyll content, leading to elevated biomass in both plants and

fruits [43]. Based on this, this research is aimed at assessing the effect of the combined use of green manure technology with biofertilizers on eggplants. Such studies were carried out in the Republic of Armenia for the first time, which, from the point of view of climate change scenarios calculated in Armenia, is especially significant for the semi-desert zones of the Ararat Valley, where the experiments were carried out. There are limited studies on the impact of green manuring on qualitative particularities of eggplant. «Organit N» and «Organit P» fertilizers are new products for Armenia. Farmers indicate the effectiveness of the use in vegetable plant cultivation, but we are pioneering the science-based investigations of their use in combination with green manuring for increasing the quality and functionality of eggplant fruits.

MATERIALS AND METHODS

Materials: The used biofertilizers were obtained from the "Bionovatic" company which produces biological fertilizers. 'Organit P' is a microbiological fertilizer containing viable spores and metabolism products of the strain *Bacillus megaterium*. As it naturally occurs in the soil, the strain efficiently colonizes the rhizosphere of crop plants showing its healthy properties in the direct proximity of the roots. 'Organit N' as a microbiological fertilizer is a suspension of viable metabolically active cells of the strain *Azospirillum zeae* sp. nov. The primary function of the preparation is the amelioration of the nitrogenous nutrition of agricultural crops through the bacterial culture that is part of the composition of the micronutrient which can fix atmospheric nitrogen and transform it into forms more suitable for consumption by the plant. Both preparations are approved for use in organic agriculture in accordance with the Standards of International Accredited Certification Bodies for Organic Production, USDA-NOP Standard (205, 206), EU Regulation No. 1165/2021, Annex No. 2 and EU No. 848/2018 [44]. For these experiments, the locally bred 'Karine' F1 eggplant was used. Karine F1 is an early ripening hybrid, with 100 days duration from mass germination to technical maturity stage and yield of 400.0 c/ha. The height of the bush is 120.5 cm, upright, the foliage is strong. The shape of the fruit is oblong cylindrical. The color of the fruits is close to black. Average weight 280.5g, length 35cm.

Experimental site and plots: The research trials were conducted at the experimental farm of the Scientific Centre of Vegetables and Industrial Crops with irrigated meadow grey soil located in community Darakert of Ararat marz (province) of Armenia between 2020-2022. The experimental farm is 650-700º above sea level where the average temperature of the coldest month (January) is −2.6 °C, the hottest month (July) is 26.2 °C; the calculated long-term precipitation rate is 289 mm. [45].

Beans (Phaseolus vulgaris L.), green peas (Pisum sativum L.) and soybeans (Glycine max (L.) Merr.), belonging to the Fabaceae L. family, were used as green manure for eggplants. The total size of the experimental field was 1800m2. The field was mowed during the period of intensive flowering of the green manure plants. Loosening to a depth of 10-15 cm was carried out to introduce green mass into the top layer of soil. The following experimental plots were laid out, each 100 m^2 in size: 1. control, without green manure and without the use of biofertilizers; 2. without green manure, treated only by biofertilizers; 3. soybean; 4. soybean and biofertilizers; 5. bean; 6. bean and biofertilizers; 7. pea; 8. pea and biofertilizers. The planting scheme for eggplant seedlings is 70 cm between rows and 30 cm between plants. The experiment was set up by a block-randomized method in 4 replications.

Treatment and analyses: Plants of eggplants were nourished with biofertilizers 'Organit N' and 'Organit P' together at the beginning of intensive growth (1 l/1000m^2 of each preparation). In the beginning of fruiting stage, the foliage of eggplants was treated with

both biofertilizers with a concentration of 300 l/ha. Soil analysis (N, P, K) and the content of macro- and micronutrients (K, Ca, Mg, P, Fe) in eggplant fruits were done at the Organic Agriculture Laboratory of Armenian National Agrarian University with a photometric LASA-AGRO 3900&1900 workstation with the variable cuvette sizes (10- 50 mm thickness) that allowed for wide measuring ranges including the soil analysis and macro elements in stock solutions. Soil analyses were done before sowing of green manure plants and at the end of crop vegetation period. The content of dry matter in the fruits was determined by the refractometric method. The content of total sugars was determined according to Bertrand's method based on the reducing action of sugar on the alkaline solution of tartrate complex with cupric ion. The analysis of B1 and C vitamins was implemented using the spectrophotometer (Cary 60 UV-Vis). The method is grounded on the quantitative evaluation of reduced and oxidized riboflavin at a wavelength of 445 nm in relation to a solvent (0.1N HCl solution) [46].

Statistical Analysis: The experimental data was subjected to statistical processing using the ANOVA method. Analyses data were expressed as means ± standard deviations (SD). The data was analyzed using F-test at level 5% to find out variance results of the tested variants on pepper yield and analyzed biochemical elements in soil and fruits of eggplant.

RESULTS

Agrochemical indicators of soil depending on used green manure and biofertilizers: The results of the studies conducted to assess the quantity of bioactive elements and the corresponding functionality of vegetables demonstrated a direct dependence of the content of bioactive elements on the quality of the soil that nourishes the plants growing on it [47-48]. In our experiments, the applied technology of using green manure plants and biofertilizers also had a great impact on soil quality, crop yields and the quality of the resulting products.

The agrochemical analyses of the soil indicated that introducing green manure into the soil, as opposed to the control, resulted in a reduction in the volumetric weight of the soil ranging from 7.2% to 16.8%.The most improved indicators were observed in the variant where soybean was used as a manure crop - 16.8%.

Application of biofertilizers in soil without green manure reduced the volumetric weight by 2.6%, but in fields with green manure with all experimental crops, the combined use of biofertilizers did not significantly change the soil volumetric weight (Table 1). Green manure has a positive effect on the accumulation of nitrogen, phosphorus, and potassium available to plants in the soil. When soybean was used as green manure, the accumulated nitrogen in 100 g of soil sample was the highest, exceeding the control by 2.46 mg, and when adding beans and peas, the values exceeded the control by 1.98 and 1.3 mg. The use of biofertilizers 'Organit N' and 'Organit P' led to an additional increase in accumulated nitrogen by 1.5 mg, 0.41 mg and 1.16 mg, respectively.

The phosphorus content in 100 g of soil sample exceeded the control in case of use of soybeans as manure crop by 1.0 mg, in case of use of beans and peas - by 0.8 mg, and potassium content increased by 3.7 mg, 1.3 mg and 0.3 mg, respectively. The analysis of the results of the use of biofertilizers demonstrated a significant increase in the phosphorus content in the soil with soybeans - 0.68 mg, bean, and pea - 0.8 mg and 0.8 mg, and potassium 0.6 mg and 0.7 mg, respectively (Table 1).

Table 1 Soil agrochemical indicators of the experimental plot depending on applied technology.

Variants	Volumetric weight, g/cm³	pH	Nutrients available to plants, mg in 100 g of soil		
			N	P_2O_5	K_2O
1. Control	1.18±0.01	8.0±0.02	3.82±0.00	1.46±0.00	47.5±0.02
2. Control +N+P	1.15±0.01	7.7±0.01	4.68±0.00	2.04±0.01	49.0±0.02
3. Soybean	1.01±0.02	7.6±0.00	6.28±0.00	2.46±0.00	51.2±0.00
4. Soybean +N+P	1.00±0.01	7.5±0.01	7.78±0.01	3.14±0.02	52.0±0.00
5. Bean	1.10±0.00	7.8±0.00	5.80±0.02	2.35±0.02	48.8±0.01
6. Bean +N+P	1.10±0.01	7.5±0.01	6.21±0.01	3.21±0.01	49.4±0.01
7. Pea	1.03±0.01	7.8±0.02	5.12±0.00	2.3±0.00	47.8±0.01
8. Pea +N+P	1.04±0.01	7.7±0.03	6.28±0.00	3.1±0.00	48.5±0.01
LSD	0.11	0.08	0.05	0.04	0.05

Content of dry matter, total sugars, vitamin C and acidity in eggplant fruits depending on used manure crop and biofertilizers: Dry matter is an important indicator for measuring the fruits' nutrition composition, including starch, cellulose, protein, fat, inorganic minerals, etc. [49]. The studies on the effect of applying green manure and foliage treatment with 'Organit N' and 'Organit P' fertilizers on fruit quality indicators of eggplant showed significant increase in dry matter compared to the control (Figure 1).

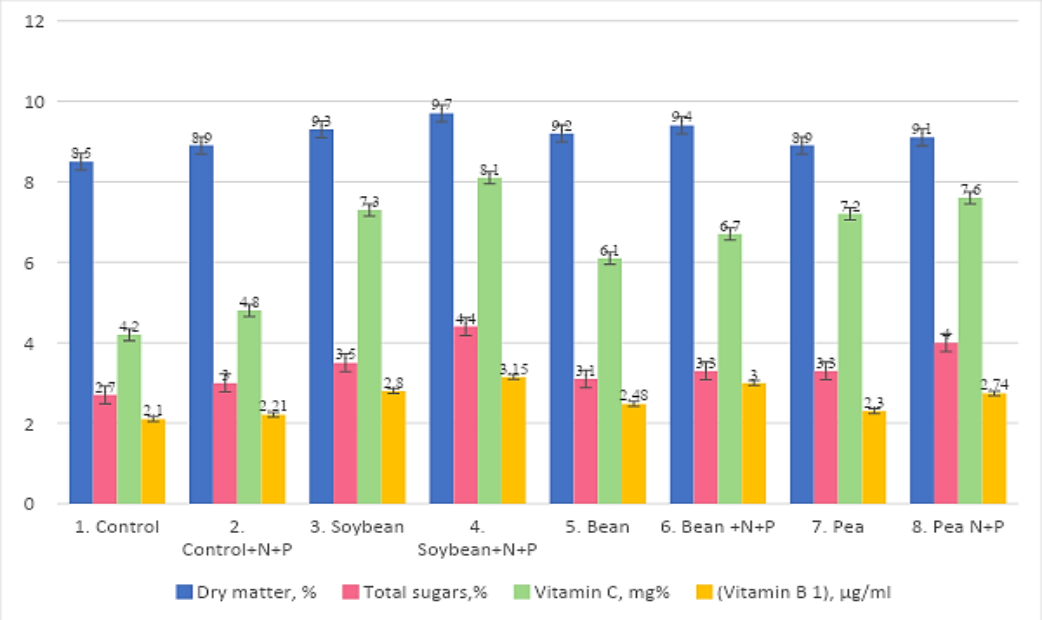


Figure 1. Biochemical parameters of eggplant fruits depending on technology

The spray dressing of plants with 'Organit N' and 'Organit P' fertilizers without green manure (control variant) contributed to the increase of dry matter in eggplant fruits by 0.4%. In all versions of green manuring with 'Organit N' and 'Organit P' fertilizers treatment, the content of dry matter significantly exceeded the Control+ N+P. The plants of the Soybean +N+P version stood out with the maximum amount of dry matter in the fruits accumulating 0.8% more dry matter compared to the versions treated only with fertilizers Control +N+P. The Pea +N+P variant stood out with the lowest content of dry matter inferior to the plants of the Soybean +N+P variant by 0.6%, to Bean +N+P by 0.3%, but surpassing the Control +N+P by 0,2%.

Sugar, which occurs naturally in many vegetables, is a carbohydrate that the body breaks down to produce glucose, which is needed for energy and healthy functioning, making the sugar content of fruits important in terms of functionality [50]. Data analysis showed that the presence of green manure in the soil contributes to a quantitative increase in total sugars in eggplant fruits. The use of soybeans, beans and peas in green manure resulted in an increase in total sugars compared to control plants by 0.8%, 0.4% and 0.4% respectively. The spray dressing control plants with fertilizers 'Organit N' and 'Organit P' (option Control +N+P) led to an increase in sugars in fruits by only 0.3%, while in the experimental plots with the combined use of green manure and biofertilizers, the sugar content in the soybean version exceeded Control +N+P plants by 1.4%, in the Bean +N+P option - by 0.3% and in the Pea +N+P variant - by 1.0%. As can be seen from the data analysis, the highest improvement indicators, as in previous analyzes, are noted in the Soy +N+P option.

The content of Vitamin C in vegetable fruits is also an essential indicator of functionality, considering the role of this vitamin in the metabolic functions of the body (activation of vitamin B, folic acid, cholesterol conversion), and in protective functions in many diseases and disorders associated with the immune system [51]. The technology used had a positive effect on the accumulation of vitamin C in eggplants. Thus, according to Figure 1, the content of vitamin C in the fruits of the option of using soybeans as a manure crop exceeded the control by 3.3%, in the option with beans - by 1.9%, in the option with peas - by 3.0%.

In addition to the noted positive effect of green manure on the content of vitamin C, the use of green manure, both separately and together with 'Organit N' and 'Organit P', as research results show, has also led to positive changes in the content of vitamin B1 in eggplant fruits. Thus, when using soybeans as green manure, the thiamine content in fruits increased by 1.7 µg/ml, in the case of beans - by 1.08 µg/ml, and in the case of peas - by 0.89 µg/ml.

The findings of this research underscore that the simultaneous application of green manure and Organit N+P fertilizers, irrespective of the specific green manure species, facilitates the activation of vitamin B1 accumulation in fruits. Thus, the content of vitamin B1 in the Control +N+P variant exceeded the Control option indicator by 0.3%, and with the addition of green manure this indicator exceeded the control by 2.05% in the Soya +N+P variant, by 1.9 in the Bean +N+P variant, and by 1.64% in the variant Pea +N+P. Naturally, compared to the Control +N+P option, these indicators are slightly reduced, amounting to 1.74% in the case of Soy +N+P, 1.59% in Bean +N+P variant and 1.33% in case of Pea +N+P. From the results of the analysis, it is obvious that the use of soybean as a green manure crop acts more intensively than the application of beans and peas on the accumulation of vitamin B1.

In agricultural sciences, the fundamental understanding prevails that macronutrients play a pivotal role in the growth and productivity of crops. The precise proportions of these essential elements significantly impact the proper development, quality, and quantity of the crop. At the same time macronutrients provide calories which are turned into energy needed for the normal growth, metabolism, and other functions of the human body. Considering the importance of macronutrients that a person receives from plant products, the analysis of effects of green manure and biofertilizers application was the content of macronutrients in eggplant was also done. From a quantitative point of view, iron, calcium, potassium, phosphorus, and magnesium predominate in eggplant fruits. Both green manure crops and their combination with biofertilizers contributed to an increase in all macronutrients in all treatment options. Thus, iron increased by 19.0% - 35.5%, calcium - 6.6% - 30.8%, potassium - 5.6% - 36.3%, phosphorus - 2.7 - 37.8, magnesium - 3, 15% - 25.0%. Iron increased most in the variants fertilized with pea and soybean, when applying biofertilizers, and calcium in the option of usage beans as manure crop. Potassium increased in the variant of use pea and biofertilizers. Phosphorus increased most when soybeans were used as green manure, and magnesium increased when beans and peas were applied together with biofertilizers (Table 2).

Table 2. Content macro- and micronutrients in eggplant fruits depending on used technology, mg/kg

Variants	Fe	Ca	K	P	Mg
1. Control	44.2±1.1	335.5±0.5	1555±1.2	18,5±0.3	132.5±1.3
2.Control +N+P	49.2±0.9	357.3±0.4	1643±1.4	19.0±0.2	136.7±0.7
3. Soybean	55.5±0.8	375,5±0.6	1850±17	22.4±0.1	150.3±0.4
4. Soybean +N+P	59.2±1.1	393,3.7±0.7	1908±1.8	25.5±0.3	160.5±0.9
5. Bean	52,5±0.5	423.5±0.1	1880±1.5	21.3±0.4	152.4±0.9
6. Bean +N+P	56.3±0.4	438.2±0.7	2005±0.9	24.2±0.2	165.4±1.1
7. Pea	52,2±05.	368.3±0.5	1852±1.2	20.3±0.2	152.3±1.4
8. Pea +N+P	59.9±0.6	410.2±0.3	2120±1.6	22.3±0.1	165.7±1.1
LSD $_{0.05}$	1.2	6.2	9.2	1.2	2.6

The decisive factor determining the effectiveness of the applied cultivation technology is crop yield, which is essential both in terms of obtaining a quality harvest and food functionality. The average eggplant yield was calculated in all variants of the carried-out experience and compared with control. The yield of eggplants increased because of the addition of green manure crops. Depending on the crop used as green manure, the yield increased from 40 to 121.5 t/ha (Table 3). And the combined use of green manure and biofertilizers 'Organit N' and 'Organit P' contributed to an increase in yield by 60 to 163 c/ha. The yield increase was recorded in both variants: without biofertilizers and with the use of 'Organit N' and 'Organit P'. Soybeans provided an increase of 30.4% without spraying with biofertilizers and 40% in the option of using biofertilizers.

Table 3. The effect of using green manuring plants and bio-fertilizers on eggplant yield.

Variants	Average yield c/ha	Compared to control	
		c/ha	%
1. Control	401.5	-	
2. Control +N+P	437.3	35.8	8.8
3. Soybean	523.0	121.5	30.4
4. Soybean +N+P	565.2	163.7	40.0
5. Bean	484.2	82.7	20.6
6. Bean +N+P	502.0	100.5	25.0
7. Pea	442.0	40.5	10.1
8. Pea +N+P	462.0	60.5	15.1
LSD	6		
Sx%	0.8		

DISCUSSION

The functionality of eggplant fruits depends on the amount of nutrients present in the fruits, which, in turn, depends on the crop cultivation technology. Environmentally friendly technologies implemented to improve soil quality and ensure obtaining ecologically

clean products directly lead to crops rich in biologically active substances beneficial to the body. One such technology is green manure, confirmed by the results of research conducted by a few researchers [24-28].

The data obtained from our experiments confirm that the application of green fertilizers helps improve soil quality. Because studies by several authors indicate that legumes contribute most to increasing nutrients in the soil, we used soybeans, beans, and peas as green fertilizers in our experiments [29-31]. In our experiments, their introduction into the soil contributed to a decrease in the volumetric weight of the soil by 7.2-16.8%, and an increase in the content of nutrients (nitrogen, phosphorus, potassium) in the soil. Thus, according to soil analysis, the amount of nitrogen in 100 g of soil increased by 1.3-2.46 mg, phosphorus by 08-1.0 mg and potassium by 0.3-3.7 mg. The maximum improvement was in the option of using soybeans as green manure. The works of Javanmard A, Surender S, Agdebe TM and several other authors indicate the effectiveness of the combined use of green fertilizers and biofertilizers [32-36]. Our research confirmed the findings of those other researchers. Thus, the introduction of biofertilizers into the soil and foliar spraying of plants contributed to an increase in nutrients in 100 g of soil: nitrogen by 0.41-1.5 mg, phosphorus - by 0.8-1.0 mg, potassium - by 0.3-3, 7 mg. The noted effectiveness of the applied technology is explained by the characteristics of legumes to fix atmospheric nitrogen, and on the other hand, by the influence of the activity of Azospirillum zeae and Bacillus megaterium strains present in the biofertilizers we tested, which stimulate the development of endomycorrhizal, ectomycorrhizal and other type of beneficial microorganisms that enrich the soil with nutrients substances and stimulate their absorption by eggplant plants [37-40]. The same factors explain that the application of green fertilizers and biofertilizers increases the dry matter content in eggplant fruits by a maximum of 1.2%, sugars by 1.7%, vitamin C by 3.9 mg% and vitamin B1 by 0.05. µg/ml. The quantity of macronutrients in eggplant fruits also increased compared to the control. We concur with the elucidation provided in the works of P.K. Ghosh [29] and others, wherein the inclusion of legume green manures is associated with a solubilizing impact on macronutrients—such as nitrogen, phosphorus, potassium—and micronutrients (zinc, iron, manganese, and copper) in the soil. Additionally, this practice can mitigate nutrient deficiencies by recycling nutrients through green manuring. The incorporation of legume green manures and their subsequent decomposition results in a consequential effect, facilitating their efficient absorption by plants. Our research data are in line with the results of the studies conducted by Javanmard A., Adekiya, AO, Agbede TM, and others which defined a positive effect of combined use of green manuring with different kinds of fertilizers on soil quality, plant growth, yield and mineral nutrients and vitamin C content in tomato, okra, peppermint fruits [31,34-35]. The tested technology is off special importance for Armenia considering food security and food safety that improvement is on the country's economy development agenda. In addition, the use of experienced technology leads to an increase of bioactive compounds (of vitamin C and B1), which are the backbone of functional food products in accordance with existing theory of Functional Food Center [52]. That in turn will contribute to the development of healthy diets to prevent human chronic diseases.

Although the impact of biofertilizers have been tested many times by different producers engaged in organic farming, the idea of enhancing positive effect of biofertilization through their combined use with green manure was tested at the first time. The positive results obtained provide for the basis for further experiments on testing and introducing developed technology on other crops to increase content of bioactive compounds in different crops.

An increase in the functional activity of eggplant fruits because of the applied technology provides grounds for considering such fruits as a functional food, according to the definition of the Food Functional

Center and further clinical testing to reduce the risk of several chronic diseases [53-54].

The health benefits of functional ingredients and accordingly the immune responses they cause depend on the content of the bioactive compounds in functional foods [55].

CONCLUSION

Based on the results obtained in this study, we can conclude that the combined use of green manure and biofertilizers leads to an increase in the functionality of eggplant fruits by improving soil quality, increasing the content of macronutrients such as vitamins C and B1 in eggplant fruits. Vitamin C and B1 as important bioactive compounds must be widely incorporated into food products in order to enhance food nutritional and health properties. In this context the role of developed green technology is of high importance.

The registered positive effect of the technology used on the yield and quality of eggplants, together with the improved starting point for researchers to study the proposed technology on other crops. Meant in the functional properties of eggplant fruits, will be recommended to farmers.

The functional properties of eggplant fruits that have been enhanced due to the rise of the content of vitamins C and B1 provides grounds for considering such fruits as a functional food and for further clinical testing to reduce the risk of a number of chronic diseases.

List of Abbreviations: N, 'Organit N'; P, 'Organit P'; K, Potassium; Ca, Calcium; Mg, Magnesium; P, Phosphorus; Fe, Iron

Competing interests: The authors declare that they have no competing interests.

Authors' contributions: GM, AP and KS designed the research. GM, AP, GK and AA conducted the research. AP and GA performed biochemical analysis. GM performed statistical analyses. GM and AA wrote the manuscript. MZ edit the article. All authors read and approved the final version of the manuscript.

Competing Interests: There are no conflicts of interest to declare.

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