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I. INTRODUCTION

Nitrogen is known to be one of the main essential elements forming a part of amino acids, DNA, ATP and other major organic substances [1]. In general, live organisms are not capable of fixing molecular nitrogen from atmospheric air though Earth's atmosphere, which is composed of about 78% nitrogen gas. Nitrogen-fixing bacteria, in particular, Azotobacter chroococcum, are able to obtain this gas from the atmosphere and are the first known type of such microorganisms. They can live in conditions of increased content of carbon dioxide and fix nitrogen in aerobic conditions [2]. The application of biostimulators, containing these bacteria and other useful microorganisms, in crop production contributes protein (consisting of amino acids) in agricultural crops and is very important for human adequate nutrition.

Recently the application of plant biostimulators containing beneficial microorganisms has become more urgent due to organic agricultural development.

Biostimulators differ from other fertilizers as they can contribute to plant growth when kept in small amounts. The term "biostimulator" was first applied by Kauffman et al. [3], has become more popular in the following years, embracing a broader range of elements [4-6]. A plant biostimulator is any substance or microorganism applied to plants with the purpose to enhance nutrition efficiency, abiotic stress tolerance and to improve crop quality [7-8]. Biostimulators promote root and fruit formation in plants, facilitate nutritional and water taking, their transportation and utilization from the soil, increase plant disease resistance and recovery after biotic and abiotic stresses, improve metabolic processes in plants, contributing to crop output and quality.

It is well-known an important role that play effective soil microorganisms in creation of optimal environment for soil nutrition of plants [9]. Plant growth promoting rhizobacteria are multifunctional and affect plant lives in all aspects: nutrition and growth, morphogenesis and development, biotic and abiotic stress tolerance, interaction with other organisms in agroecosystems [10-17].

Mycorrhizal fungi form symbiotic associations with 90% of all plants. An arbuscular mycorrhizal fungus (AMF) is a widespread type of endomycorrhizal fungi [18-19]. There is a growing concern of

mycorrhiza utilization for plant nutrition, water balance provision, plant protection against biotic and abiotic stresses [20-25]. Gifalny networks can connect not only fungi and plant partners, but also some plants in the plant community [26-27].

The utilization of nonpathogenic soil bacteria, living in plant roots, is very perspective and opens considerable opportunities for organic farming [28-30]. The bacteria belonging to Bacillus type, especially Bac. subtilis, can be used for effective biocontrol of different plant diseases caused by soil pathogens [31-33]. Fungal entophytes, such as Trichoderma, are capable of colonizing plant roots transporting nutrients to them [34].

The biostimulant application on the basis of beneficial microorganisms (bacteria and fungi) for producing ecologically safe crop products with the optimum composition of amino acids, vitamins, antioxidants, vital chemical elements and other substances, essential to human health, is one of the most important problems of agriculture.

In the study we conduct the research on how biostimulants with beneficial microorganisms influence amino acids concentrations in red beetroots.

II. EXPERIMENTAL

The investigated biostimulator applied for red beet planting contains: nitrogen-fixing Azotobacter chroococcum bacterium, Trichoderma harzianum fungus and Bacillus subtilis bacterium as antagonists of phytopathogenes, and Bacillus megaterium bacterium as an immunomodulator. Except for purging phytopathogenes in the rhizosphere of plant roots, the spore-forming Bacillus subtilis bacterium has high enzymatic activity and decomposes different organic substances in the soil. The Bacillus megaterium bacterium triggers the natural defense response in plants and induces their immunity, it also regulates nutritious elements received by plants from the soil. Trichoderma harzianum fungus is an effective bioagent aimed at fighting against root rots, it suppresses the development of disease excitants in plants. Except for useful microorganisms, the investigated biostimulant contains the organic and mineral structure.

In our research we use red beet of the short-season «Gleb» variety. The period between seedling and harvesting stages lasts 80-100 days. The average weight of this beetroot is 200-300 g, it has intensive-purple coloring, is smooth-skinned, has flattened shape and rounded oval form. This variety is versatile in use, resistant to premature seeding and can be kept well.

The experiment was conducted on the sod-podzolic moderately clayey soil of the Moscow region. The field experience laid out on the following scheme: 1) control group; 2) biostimulant group. Red beet was sowed on sample plots 50 sq. m in area, with 4-fold frequency. The biostimulant was applied twice during vegetation with a time interval of a month. It was previously dissolved in water in the quantity of 10 g of stimulator per one sample plot and then plants were watered with the subsequent soil loosening. In 90 days after seeding the beetroots were removed and measured on the content of amino acids.

The amino-acid composition of beetroots was estimated by means of capillary electrophoresis method on analyzer Kapel -105 M.

III. RESULTS AND DISCUSSION

Red beet is the most widespread and major vegetable culture with the high content of essential vitamins for humans (groups B, C, PP, etc.), betaine, sugars, protein, folic acid, vital macro -

microelements (magnesium, potassium, calcium, iron, iodine and especially silicon and chrome), bioflavonoids. Its root crops contain both the irreplaceable, and replaceable amino acids which are part of protein. This vegetable culture renders general tonic influence on human organisms, as well as digestion and metabolism improving effects.

The lack of protein in human nutrition breaks normal organism life activity and leads to serious negative effects. Amino acids, irreplaceable for the majority of animals and human beings, are valine, isoleucine, leucine, threonine, methionine, lysine, phenylalanine, tryptophane, arginine, histidine. Replaceable amino acids include glycine, alanine, proline, serine, cysteine, aspartic acid, glutamine acid, tyrosine.

In our field experience we determined the contents of 17 amino acids (Table) in red beet of short-season «Gleb» variety cultivated with the innovative biostimulant.

Table: Amino-acid composition of «Gleb» variety red beet (g/kg of dry weight)

Indicators of amino-acid composition	Experimental group	Control group
Aspartic acid	4.72±0.40	2.67±0.21
Threonine	1.67±0.16	0.92±0.08
Glutamine acid	24.14±2.11	7.41±0.69
Serine	2.74±0.23	1.31±0.11
Proline	1.46±0.12	0.40±0.01
Glycine	0.94±0.08	0.47±0.04
Alanine	1.80±0.16	0.73±0.07
Cysteine	1.12±0.10	0.64±0.05
Valine	0.003±0.000	0.001±0.000
Isoleucine	1.20±0.13	0.20±0.00
Leucine	1.66±0.15	0.97±0.09
Tyrosine	1.05±0.09	0.80±0.07
Phenylalanine	0.67±0.06	0.46±0.04
Histidine	0.84±0.07	0.58±0.05
Lysine	1.51±0.13	0.70±0.07
Arginine	1.30±0.09	0.40±0.000
Tryptophane	0.43±0.04	0.38±0.03
Total amount of amino acids	47.25±4.21	19.04±1.56
Including irreplaceable	9.28±0.90	4.41±0.41
Crude protein, %	7.43±0.67	6.56±0.58

The total amount of amino acids was 2.5 times higher in the samples planted with the biostimulator, compared to the control ones, 47.25 g/kg and 19.04 g/kg of dry weight consequently. As far as the total amount of essential amino acids is concerned, it increased by 2.1 times (from 4.41 g/kg in the control group to 9.28 g/kg of dry weight in the experimental one).

Applied biostimulant contributed to the increased content of all investigated amino acids: tryptophane – by 1.1 times (from 0.38 to 0.43 g/kg of dry weight), tyrosine – by 1.3 times (from 0.80 to 1.05 g/kg of dry weight), histidine – by 1.4 times (from 0.58 to 0.84 g/kg of dry weight), phenylalanine - by 1.5 times (from 0.46 to 0.67 g/kg of dry weight), leucine – by 1.7 times (from 0.97 to 1.66 g/kg of dry weight), aspartic acid (from 2.67 to 4.72 g/kg of dry weight), threonine (from 0.92 to 1.67 g/kg of dry weight) and cystine (from 0.64 to 1.12 g/kg of dry weight) – by 1.8 time, glycine – twice (from 0.47 to

0.94 g/kg of dry weight), serine – by 2.1 times (from 1.31 to 2.74 g/kg of dry weight), lysine – by 2.2 times (from 0.70 to 1.51 g/kg of dry weight), alanine – by 2.5 times (from 0.73 to 1.80 g/kg of dry weight), valine – by 3 times (from 0.001 to 0.003 g/kg of dry weight), arginine (from 0.40 to 1.30 g/kg of dry weight) and glutamine acid (from 7.41 to 24.14 g/kg of dry weight) – by 3.3 time, proline – by 3.7 times (from 0.40 to 1.46 g/kg of dry weight), isoleucine – by 6 times (from 0.20 to 1.20 g/kg of dry weight).

Accumulated beneficial microorganisms in beetroots led to several times increase in the content of such essential amino acids as valine, isoleucine, lysine. Valine is an important amino acid which is associated with normal metabolism in brain muscle tissues, it also participates in body regeneration processes. The isoleucine has the immunostimulating properties, it is an important component of hormone and enzyme synthesis, it also promotes muscle gains. Lysine is necessary for synthesis of the major organism proteins – nucleoproteids. The lack of this amino acid delays formation of communicating tissues.

IV. CONCLUSION

Planting of «Gleb» variety red beet with the application of the biostimulant containing nonpathogenic microorganisms Azotobacter chroococcum, Bacillus subtilis, Bacillus megaterium and Trichoderma harzianum contributed to the increased contents of 17 amino acids in its beetroots, such as valine, isoleucine, leucine, threonine, lysine, phenylalanine, tryptophane, arginine, histidine, glycine, alanine, proline, serine, cysteine, asparaginic and glutamine acids, tyrosine, nine of which are irreplaceable.

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