

Brief information about the project

Name of the project	AP26101745 Application of cyanobacterial strains for the production of organic fertilizers and plant biostimulants in agriculture.
Relevance	In recent years, increasing attention has been paid to sustainable agriculture, aimed at maintaining soil fertility and a healthy ecosystem with minimal costs. On the other hand, to meet current food demand, agriculture actively uses agrochemicals, such as synthetic fertilizers and pesticides, intensive soil cultivation, and excessive irrigation, leading to environmental pollution, high greenhouse gas emissions, and loss of key ecosystem services. Many agricultural soils suffer from a lack of essential nutrients, such as nitrogen, phosphorus, potassium, and iron, leading to the consumption of 200 million metric tons of chemical fertilizers. This has resulted in soil compaction, acidification, decreased fertility, and disruption of soil microbial balance, exacerbating soil diseases. Moreover, producing the required amount of synthetic fertilizers would require huge investments in fossil fuels, which is economically burdensome and causes environmental pollution. This problem necessitates the use of biodegradable, less harmful fertilizers for the soil. Sustainable agriculture should focus on methods that improve nutrient cycling to reduce the need for external resources, such as synthetic fertilizers. Currently, organic fertilizers based on peat, manure, and other organic waste are known. However, the drawbacks of these methods include the complexity and duration of obtaining the fertilizer, low nitrogen, phosphorus, and potassium content due to the long decomposition period, and the non-fixed content of nutrients. Biotechnological methods, based on the use of microorganisms as soil inoculants, are considered promising potential tools for improving soil quality. Soil microbiota plays a crucial role in nutrient balance, carbon sequestration, and soil health. Among the diverse soil microbiota, microalgae and cyanobacteria are primary producers in the food chain that can adapt to extreme conditions, such as arid, semi-arid, and wetland ecosystems. Cyanobacteria are an economical, renewable, and sustainable bioresource that can be used as soil additives and plant biostimulants. The potential of these microorganisms as valuable resources for obtaining bioactive substances is due to their unique ability to synthesize useful components, such as polysaccharides, proteins, polyunsaturated fatty acids, lipids, and other bioactive metabolites, using atmospheric CO₂. Although cyanobacteria are widespread in the soil, their potential to increase agricultural crop productivity and other opportunities remain unexplored. This project proposes to conduct applied scientific research on the development of scientific-methodological foundations for obtaining organic fertilizers based on cyanobacteria to increase agricultural crop yields and soil fertility.
Purpose	Development and introduction of effective organic fertilizers and biostimulants based on cyanobacteria strains to improve soil fertility, stimulate plant growth and reduce the use of chemical fertilizers in agriculture.
Objectives	1. Isolation and production of axenic cultures of cyanobacteria.

Water and soil samples from different ecosystems in the Republic of Kazakhstan will be selected to implement this task. The species composition of algal flora in the studied samples will be determined, and promising cyanobacterial cultures for organic fertilizers in agriculture will be isolated. Their cultural and morphological and physiological properties will be studied, and the isolated pure cultures will be identified.

1. Select isolated and collection strains of cyanobacteria based on biomass productivity.

The growth rate and biomass accumulation of isolated and collection strains of cyanobacteria will be studied to implement this task.

3. Determination of biologically active substances in cells of obtained and collection strains of cyanobacteria.

To realize this task, biochemical analysis of the properties of selected strains of cyanobacteria, including their ability to synthesize phytohormones, polysaccharides, vitamins and other substances that promote plant growth, will be carried out.

4. Determine the nitrogen-fixing capacity of isolated and collection strains of cyanobacteria.

The acetylene reduction method will be used to determine the nitrogen-fixing activity of isolated cyanobacteria, depending on external factors, and active strains will be selected.

5. Determination of optimal cultivation conditions

Develop optimal conditions for cultivation of cyanobacteria in laboratory and field conditions to maximize the accumulation of biomass and useful metabolites. Optimal conditions for mass cultivation of isolated and collection cyanobacterial cultures – potential producers of bioactive substances for biofertilizers – will be sought, including parameters such as temperature, light intensity, nutrient medium composition, pH, etc.

6. Creation of fertilizer production technologies

The effect of biofertilizers on soil microbiological and biological activity will be studied using standard microbiological methods in model experiments, and the main physicochemical indicators affecting soil fertility levels will be determined using agrochemical methods.

7. To evaluate the effect on plant growth

To determine the effect of cyanobacteria based biofertilizer on biological yield of agricultural crops.

8. Analyze the impact on soil microflora

To study the effect of biofertilizer based on cyanobacteria on soil microflora, its fertility and structure, as well as on the sustainability of soil ecosystems.

	To realize this task, the effect of biofertilizer on soil microbiological and biological activity will be studied by standard microbiological methods under the conditions of model experiments. 9. Economic and environmental assessment, as well as implementation and popularization of the results To assess the economic feasibility of the application of the developed fertilizers and biostimulants, as well as their impact on reducing the use of chemical fertilizers and reducing environmental pollution, and to develop recommendations for agricultural producers on the use of cyanobacteria-based fertilizers and organize activities to promote this technology, including publications, seminars and webinars.
Expected and achieved results	During the project's research, axenic cultures of cyanobacteria were obtained from various aquatic and soil ecosystems, and active strains will be selected based on their biomass productivity. Work is currently underway to evaluate the biostimulating and nitrogen-fixing activity of the isolated and collected cyanobacterial strains. A fertilizer production technology will be developed, the first test batches of the fertilizer will be produced, and their impact on crop yields and soil microflora will be studied. The economic benefits and environmental advantages over traditional fertilizers will be identified and instructions and recommendations will be developed, workshops and webinars will be held for agribusinesses. Depending on the results obtained, a publication is planned: Depending on the results obtained, it is planned to publish: - not less than 3 (three) articles and (or) reviews in peer-reviewed scientific publications indexed in Science Citation Index Expanded of Web of Science base and (or) having CiteScore percentile in Scopus base not less than 50 (fifty); - at least 1 patent for invention (including a positive decision on it); - not less than 2 (two) articles or reviews in a peer-reviewed foreign or domestic publication recommended by CQASHE; - or not less than 2 (two) articles and (or) reviews in peer-reviewed scientific publications indexed in Science Citation Index Expanded and included in the 1st (first) and (or) 2nd (second) quartile by impact factor in the Web of Science database and (or) having a percentile by CiteScore in the Scopus database not less than 65 (sixty-five); - at least 2 (two) articles or reviews in a peer-reviewed foreign or domestic publication recommended by CQASHE; - or at least 1 (one) article or review in a peer-reviewed scientific publication indexed in Science Citation Index Expanded and included in the 1st (first) quartile of impact factor in the Web of Science database and (or) having a CiteScore percentile in the Scopus database of at least 80 (eighty);

	- at least 1 patent for invention (including a positive decision on it); - not less than 1 (one) article or review in a peer-reviewed foreign or domestic publication recommended by CQASHE;
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Usage	Agriculture
Priority compared to real-world alternatives	The proposed project is original and unique in the Republic of Kazakhstan. As noted above, scientific research in this area is being conducted in many countries worldwide, including the United States, Russia, Ukraine, Uzbekistan, India, Vietnam, and other countries, which are working very effectively in this area. However, it should be noted that it is more cost-effective to develop biopreparations for use on arable land in the Republic of Kazakhstan from microorganisms isolated from soil samples from these fields.
List of publications with links to them	N.R. AKMUKHANOVA, F.K. SARSEKEYEVA, G.K. DANAYEVA, A.K. S.N. SEILBEK, A.I. TOKEN, D.Ye. YERMEKOVA. Biodiversity and Biotechnological Potential of Cyanobacteria from Rice Field Ecosystems of the Balkhash Region // www.imv-journal.kz MICROBIOLOGY AND VIROLOGY №1 (52) 2026 https://imv-journal.kz/index.php/mav/article/view/693
Patents	Strain of the cyanobacterium Nostoc sp. J-1 used to increase crop yields and protect against phytopathogenic fungi/ FOR INVENTION № 37641