MODERN INNOVATIVE APPROACHES IN ENVIRONEMATALLY SAFE RURAL DEVELOPMENT

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Abstract: *Chemicalization of agriculture has violated self-regulation in wildlife, weakened the defenses of plants, animals and humans. Old, proven agricultural technologies are no longer able to cope with these problems. Mankind faced the task of finding alternative ways of farming, maintaining its high productivity and environmental safety. Under these conditions, old technologies are being replaced by biotechnology, and at the present stage only with its help it is possible to solve the environmental, energy and food problems facing humanity. This article presents the results of research on the development and implementation of a new environmentally friendly, resource-saving, cost-effective innovative bio-agrotechnology for growing agricultural crops on saline, heavy-metal degraded soils close to desertification in Uzbekistan. As a result of the application of new bioagrotechnology, the fertility of saline soils, crop yields and product quality are increased, water consumption is reduced.*

Keywords: *saline soils, biological fertilizers, bioagrotechnology, soil fertility, crops, sustainable agriculture, food security, climate change, rational use of land and water resources.*

Introduction. In recent years, agriculture, using intensive technologies, is everywhere facing the problems of land degradation, a drop in the quantity and quality of products and, as a result, a decrease in the economic performance of all economic activities in the agricultural sector. There is a need for a deep critical analysis of the development of intensive production methods, when even elementary environmental requirements were ignored in the pursuit of volume, quantity and quick profit [1].

The ever-increasing population of the planet, the constant decline in crop yields, an annual average of 30% yield loss due to pests, plant diseases and weeds were the basis for the total chemicalization of agriculture. However, such an approach provoked a global ecological crisis, putting, on the one hand, endangered the life of mankind, and on the other hand, caused serious violations in agricultural activities. As a result of chemicalization, mechanization and melioration, the chemical and physical load on the components of the agricultural landscape grew exponentially. A significant increase in the use of nitrogen, phosphorus fertilizers and pesticides (seed protectants, herbicides, fungicides, insecticides, chemical growth stimulants and pollinators) has led to the suppression of beneficial soil microflora - the basis of fertility and the activation of harmful microflora that destroys soil humus , as a result of:

- soil properties have deteriorated - structure, water permeability, aeration;
- the number of mobile forms of nitrogen, phosphorus, potassium, macro-microelements decreased;
- the level of soil fertility is catastrophically reduced;
- pathogenic microflora develops in the soil, causing various plant diseases;
- the development of the aerial parts of plants is enhanced, root formation is inhibited;
- metabolic processes in plants are disturbed, which leads to a decrease yield and quality of agricultural products in connection with the accumulation of nitrates, nitrites, pesticide residues in it;
- the environment is polluted with toxic substances as a result of the accumulation of chemicals in the soil, groundwater, plant and livestock products, causing contamination of feed and food products;
- the imbalance of the microflora of the gastrointestinal tract of the body is disturbed, which leads to the formation of many diseases (gastritis, peptic ulcer of the stomach and duodenum, liver damage, rheumatoid arthritis, joint damage, urolithiasis, bronchial asthma, dermatitis, allergic, oncological and other diseases).

[1] Kojevin P.A., Population ecology of soil microorganisms. Abstract of the dissertation for the degree of Doctor of Biological Sciences, 2006.

Thus, chemicalization violated self-regulation in living nature, weakened the defenses of plants, animals and humans. Old, proven agricultural technologies are no longer able to cope with these problems. Mankind faced the problem of finding alternative ways of farming, maintaining its high productivity and environmental safety. Under these conditions, old technologies should be replaced by biotechnology, and at the present stage only with its help it is possible to solve the environmental, energy and food problems facing humanity.

Undoubtedly, today the soil is involved in all the most important processes of the functioning of terrestrial ecosystems and the biosphere as a whole - from providing resources and space for terrestrial vegetation to maintaining the parameters of the atmosphere and hydrosphere, including the problems of greenhouse gases, the purity of surface and ground waters, and the elimination of xenobiotics[2].

An exceptional role in the formation of soil quality or "soil health" is played by soil microorganisms, which perform all the main ecosystem functions.

Modern intensive technologies in agriculture, aimed at maximizing yields and quick profits, are essentially waging a costly battle with the soil microbial system - the foundation of ecosystem resilience.

The way out of the situation is the emphasis on "soil health" in the broadest sense and its sustainable maintenance with the possibility of an acceptable livelihood for the current and future generations. That is why soil microorganisms are the main element of a sustainable and efficient life support system.

A decrease in the composition and abundance of useful soil microflora, which is involved in the circulation of important macro- and microelements, suppresses the processes of restoring soil fertility and structure, which leads to the process of soil degradation - erosion, phosphatization, salinization and desertification . As a result, greenhouse gases such as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane are released from the soil into the atmosphere, which seems to be a powerful factor in climate change on the planet[3].

Sustainable agriculture must be environmentally sound, cost-effective, socially responsible and resource-saving!

[2] Shablin P.A. EM-technology is a technology for improving the environment, 2011.
[3] Ibid

Now all over the world there is a revision of the concept of development of agricultural production and a gradual transition from intensive technogenic methods of agricultural production to biological methods.

In recent years, in a number of developed countries, in particular in Europe, the USA, Canada, Japan, China and Russia, cheap production methods have been used that bring a high effect at relatively low costs.

Main point biological farming technologies consists in applying to the soil effective microorganisms , which enrich it with readily available nutrients, make it fertile and supply plants with the necessary products of their vital activity (vitamins, enzymes, amino acids, etc.). At the same time, mineral fertilizers (only in combination with organic ones), pesticides and other chemical plant protection products are not used, the products become environmentally friendly and completely safe for humans.

Restoring degraded soils lies in the efficient and rational use of the biological potential of the soil, in optimizing the plant-microbial interaction in agrophytocenoses and improving the ecosystem as a whole.

One of the components of ecological farming is the use of new biotechnologies based on the use of biofertilizers (bacterial fertilizers, biological products, biocomposts, biofungicides, etc.).

Soil pollution also occurs when mineral fertilizers are used in excessive amounts. Recently, another an unfavorable aspect of the immoderate - consumption of mineral fertilizers and, first of all, nitrogen fertilizers. It turned out that a large amount of nitrates reduces the oxygen content in the soil, and this contributes to an increased emission of greenhouse gases into the atmosphere - nitrous oxide (N_2O) and methane (CH_4). Nitrates also have a negative effect on the human body. Thus, when nitrates enter the human body at a concentration of more than 50 mg/l, their direct general toxic effect is noted[4].

Currently, heavy metal pollution is a major environmental problem because metal ions remain in nature due to their non-degradable nature.

One of the global manifestations of soil degradation, and of the entire environment in general, is desertification.

Desertification is a process of irreversible change in soil and vegetation and a decrease in biological productivity, which in extreme cases can lead to the

[4] Protection of soils and vegetation // https://www.Studall.org.

complete destruction of the biospheric potential and the transformation of an area into a desert

On the territory subject to desertification, the physical properties of soils deteriorate, vegetation dies, groundwater becomes saline, biological productivity drops sharply, and, consequently, the ability of ecosystems to recover is undermined.

According to available data, every minute in Central Asia, 9 sq.m. of fertile land turns into a desert. The fight against salinization, degradation and desertification of soils today is one of the foundations of food security.

Materials and methods of research

Salt tolerance activity. The study of the effect of various concentrations of toxic salts on the growth activity of phosphorus-mobilizing rhizobacteria was carried out by sowing bacteria on a solid nutrient medium with increasing concentrations of the studied toxic salts[5].

Phosphate mobilizing activity. The ability of bacteria to dissolve $Ca_3(PO_4)_2$ was determined by the method of N.V. Sergeeva[6].

Potassium mobilizing activity. The potassium-mobilizing ability of bacteria was determined by the Machigin method in the modification of TSINAO[7].

Antifungal activity. To determine the antagonistic ability of bacteria in relation to phytopathogenic fungi that cause *Fusarium wilt*, root rot, *Alternaria* and other diseases of agricultural crops, the “well” method was used, which is based on the diffusion into agar of antibiotic substances accumulated by microorganisms in a liquid nutrient medium. To do this, a bacterial suspension of bacterial monoculture strains was instilled into wells made in agar. From the wells, the antibiotic substances contained in the culture liquid diffuse into the thickness of the agar, which was previously inoculated with a test culture, as a result of which zones of lack of growth formed around them[8].

Ability to decompose gypsum. Strains soil bacteria *bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 dissolve gypsum - $CaSO_4$.

[5] Zvyagintsev D.G. Methods of soil microbiology and biochemistry. Moscow, 1991.350 p.
[6] Sergeeva N.V. Influence of $Ca_3(PO_4)_2$ degrading bacteria on maize development.Ed. AN Mold. SSR. Kishinev. 1962. No. 7 p. 79-88.
[7] A large workshop on microbiology, edited by Seliber, Moscow, 1965, p. 340.
[8] Voznyakovskaya Yu. M. Plant microflora and harvest / Leningrad, 1969. - P.188-189.

The study of the effect of bacteria on the content of gypsum, pH of the medium and the survival of bacterial cells was carried out in the dynamics of deep cultivation in flasks on a liquid peptone nutrient medium (200 ml) + gypsum (6 g). Deep cultivation was carried out on a rocking chair at 220 rpm at a temperature of 28 ^{0} C for 20 days. The use of a consortium of 3 strains of soil bacteria reduced the content of gypsum in the nutrient medium by 2 times, in the control medium - without bacteria - by 0.5 times. The use of a consortium of bacteria will contribute to the dissolution of gypsum, which can positively affect the development of crops on gypsum soils[9].

Determination of heavy metals in soils. The determination of heavy metals in the soil was carried out by mass spectral with inductively coupled plasma (ICP-MS) analysis method[10].

Determination of agrochemical analyses of soils. Agrochemical analyses of soils were carried out according to the methods generally accepted in agrochemistry[11].

The pH value - the hydrogen index is measured by a standard mercury chloride electrode with automatic temperature compensation. In soil samples, the pH value is measured in an aqueous suspension of 1:5.

The humus content was determined by the Tyurin method, the determination of the gross forms of nitrogen and phosphorus was carried out by the Ginzburg et al. method, the content of mobile nitrogen N-NH4 and mobile phosphorus - P2O5 - by calorimetric method, exchange potassium K20 – by flame photometry.

The degree of soil salinity was determined by analyzing the water extract. The method is based on the content of water-extractable salts in the soil (TSS). Cations and anions were determined using the gravimetric method.

The content of toxic salts was calculated by the method of determining hypothetical salts in mg. eq/100 g of soil.

Bacterization of pure (washed with water from the tuzal protectant) wheat seeds with rhizobacteria in the field was carried out at a cell titer of 5x106 cfu/ml for 1 hour, followed by drying of the seeds in vivo.

[9]Arinushkina E.V. Manual on chemical analysis of soils.- Moscow: MSU, 1962, 491 p.
[10]Methods of quantitative chemical analysis. Determination of the elemental composition of soils, soils and bottom sediments by mass spectrometric analysis. O‘U 19660584.001:2010.
[11] Arinushkina E.V. Manual on chemical analysis of soils.- Moscow: MSU, 1962, 491 p.

Phenological observations of seed germination, plant growth and development, and root formation were carried out according to the method of staging field experiments of the Union[12].

Results and Discussion

For this reason, it is considered an urgent problem to increase fertility and obtain a high-quality crop on saline, degraded soils through the use of biotechnologies based on the use of new generation biological fertilizers that have an environmentally safe, highly effective effect on degraded soils with the ability to increase seed germination, accelerate the growth and development of plants, improve nourish roots and plants, reduce soil salinity and pollution, prevent desertification, and improve crop immunity and protect plants from diseases and pests.

We, a group of scientists and specialists of soil microbiologists, biotechnologists, soil scientists and ecologists, have developed an environmentally safe, resource-saving, cost-effective innovative bioagrotechnology for growing crops on saline, degraded, polluted with heavy metals soils close to desertification in Uzbekistan.

The new bioagrotechnology is based on the complex application of new generation bacterial fertilizers of the TERIA-S series (patent No. FAP 02090) and biological product SERHOSIL (Patent No. IAP 04933).

Useful salt-tolerant bacteria, which are part of the TERIA bacterial fertilizer , were isolated from highly saline soils of Kungrad District, Republic of Karakalpakstan.

These microorganisms have a complex of polyfunctional properties that are beneficial for the soil and plants:

- dissolve tricalcium phosphates, potassium aluminosilicates and gypsum in the soil and convert phosphorus, calcium, potassium, silicon, sulfur, nitrogen and other trace elements into forms that are assimilable for plants;
- have antagonistic activity to the main phytopathogens of agricultural crops;
- withstand high (7-10%) concentrations of toxic - NaCl , Na_2SO_4, MgCl, $MgSO_4$ and non-toxic - $Ca(HCO_3)_2$, $CaSO_4$ salts in soils;
- possess resistance to low and high soil temperatures;
- have phytohormonal and growth-stimulating activity;

[12] Dospekhov B.A. Methodology of field experience.: M. Agropromizdat. 1985. pp. 232-239.

- accumulate heavy metals in soils;
- reduce the degree of phosphatization and salinity of soils;
- normalize the alkaline pH value of saline soils.

TERIA-S bacterial fertilizer is used for

❖ pre-sowing treatment:

✓ all kinds of seeds of agricultural crops;

✓ seedlings of vegetable crops;

✓ potato tubers;

✓ seedlings of trees and shrubs;

❖ watering at the root of all types of planted crops

Biopreparation of complex action SERHOSIL is used for sheet processing of all kinds of plants and consists of green microalgae.

We have studied the following polyfunctional properties of microorganisms that are part of the bacterial action TERIA-S: salt tolerance, potassium mobilizing activity, phosphate mobilizing activity, antifungal activity, ability to decompose gypsum, properties of accumulation of heavy metals in the soil.

1. Salt tolerance activity. Strains from the composition of the TERIA-S bacterial fertilizer - *Bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 have high salt-tolerant activity. The influence of increasing concentrations of sulfate (Na_2SO_4 and $MgSO_4$) and chloride (NaCl and $MgCl_2$) toxic salts on their growth activity. The strains showed good growth in the presence of increasing concentrations from 3% to 10% of the above toxic salts in the peptone nutrient medium.

2. Phosphate mobilizing activity. Strains soil bacteria have phosphate-mobilizing activity, as evidenced by the results of a study of the dissolution of $Ca_3(PO_4)_2$. Strains *bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 showed the dissolution zones of $Ca_3(RO_4)_2$ on the Pikovskaya medium – 30 (±1.5) mm, 31(±1.2) mm and 12(±1.6) mm, respectively.

The mobilization of P_2O_5 from $Ca_3(PO_4)_2$ by *Bacillus subtilis* K-4, *Bacillus thuringiensis* K-7, and *Priestia megaterium* K-8 strains was studied when the strains were cultivated on a peptone medium with a single source of phosphorus $Ca_3(PO_4)_2$: mobilization of P_2O_5 from $Ca_3(PO_4)_2$ in strains of *Bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 was 115±0.12 mg P_2O_5/100 ml, 128±0.15 mg P_2O_5/100 ml and 128±0.1 mg P_2O_5/100 ml respectively.

3. Potassium mobilizing activity. Strains soil bacteria *bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 dissolve potassium aluminosilicates $KAlSiO_4$, as evidenced by the dissolution zones of $KAlSiO_4$ strains on solid nutrient media Zak and A-27. The strains showed the following dissolution zones on the 2 media above, respectively: *Bacillus subtilis* K-4 - 50 ± 1.6 mm and 20 ± 1.4 mm; *Bacillus thuringiensis* K-7 - 20 ± 1.5 mm and 20 ± 1.9 mm; *Priestia megaterium* K-8 - 30 ± 1.4 mm and 20 ± 1.3 mm. Thus, it has been proven that *Bacillus strains subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 have a high potassium mobilizing activity. The release of mobile and water-soluble potassium from potassium aluminosilicate ($KAlSiO_4$) was tested. Mobilization of mobile potassium from $KAlSiO_4$ was 1265 mg/kg in the strain *bacillus subtilis* K-4, in *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 - 1229 mg / kg. Release of water-soluble potassium from $KAlSiO_4$ was 0.048 g/l *bacillus subtilis* K-4, in *Bacillus thuringiensis* K-7, this figure was 0.047 g/l and 0.049 g/l in the strain *Priestia megaterium* K-8.

4. Antifungal activity. The antifungal activity of strains of *Bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 was tested by the well method. It was found that the studied strains to some extent have antifungal activity against phytopathogenic fungi *Fusarium moniliforme, Alternaria alternata, Alternaria solani, Fusarium solani, Fusarium oxysporium, Aspergilius niger* and *Cladosporium oxysporum* (Table 1).

Table 1.

Growth Inhibition of Phytopathogenic Fungi by Salt Tolerant Soil Bacteria

Phytopathogens c/ x crops	**Zone of inhibition growth**	**Soil bacteria strains**		
		Bacillus subtilis K-4	*Bacillus thuringiensis* K-7	*Priestia megaterium* K-8
Fusarium moniliforme	D, мм	50,0±0,58	75,0±0,58	50,0±0,58
Alternaria alternata,940	D,мм	70,0±1,53	50,0±1,53	90,0±1,43
Alternaria alternata,975	D,мм	60,0±1,2	18,0±0,2	20,0±0,2
Alternaria alternata,650	D,мм	28,0±0,2	30,0±0,2	60,0±1,2

Alternaria solani,986	D,мм	11,3±0,1	12,4±0,1	14,0±0,2
Alternaria solani,809	D,мм	-	14,0±0,2	-
Fusarium solani	D,мм	-	-	51±0,58
Fusarium oxysporum	D,мм	11,6±0,1	10,2±0,1	-
Aspergilius niger	D,мм	11,2±0,1	8,3±0,1	15,6±0,2
Cladosporium oxysporum	D,мм	13,2±0,2	14,1±0,2	-

5. Ability to decompose gypsum. Strains soil bacteria *bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 dissolve gypsum - $CaSO_4$.

The study of the effect of bacteria on the content of gypsum, pH of the medium and the survival of bacterial cells was carried out in the dynamics of deep cultivation in flasks on a liquid peptone nutrient medium (200ml) + gypsum (6g). Deep cultivation was carried out on a rocking chair at 220 rpm at a temperature of 28 ^{0}C for 20 days.

The use of a consortium of 3 strains of soil bacteria reduced the content of gypsum in the nutrient medium by 2 times, in the control medium - without bacteria - by 0.5 times. The use of a consortium of bacteria will contribute to the dissolution of gypsum, which can positively affect the development of crops on gypsum soils.

6. Properties of accumulation of heavy metals in the soil. In the last decade, under the influence of high anthropogenic loads, agrolandscapes have been polluted with various ecotoxicants (mercury, lead, cadmium, fluorine, aluminum, arsenic), which are considered toxic heavy metals.

Exceeding the norms of toxic substances leads to a violation of soil quality, an increase in pests and plant diseases, and a decrease in the quality of agricultural products. This negatively affects the health of people and animals.

Thus, the use of nitrogen fertilizers increases the acidity of soils, increases the mobility of heavy metals (aluminum, cadmium, copper, lead) and leads to the accumulation in the soil of toxic elements for plants and microorganisms, in particular fluorine.

Potash fertilizers, and especially potassium chloride (with excessive application), chlorine and lead are deposited in the soil , soil acidity increases, and the activity of soil microorganisms decreases.

Strains soil bacteria *bacillus subtilis* K-4, *Bacillus thuringiensis* K-7 and *Priestia megaterium* K-8 are able to reduce the adverse effects of heavy metals entering the soil along with mineral fertilizers and pesticides, increase the fertility of saline, polluted degraded soils, reduce the consumption of heavy metals by plant organs, and increase productivity and product quality.

When using a consortium of 3 strains of bacteria (bacterial fertilizer TERIA-S) and biopreparation SERHOSIL, the amount of toxic heavy metals in the soil decreased compared to the control, without the use of bacteria against the background of mineral fertilizers (NPK): the amount of Zn in the soil decreased by 69.8 mg/kg, Cd - by 0.149 mg/kg , Pb - by 72.5 mg/kg, Mo - by 0.38 mg/kg, Cu - by 58.2 mg/kg, Co - by 7.8 mg/kg, Ni - by 29.9 mg/kg , As - by 2.1 mg/kg and Cr - by 18.7 mg/kg (Table 2).

Table 2

Influence of bacterial fertilizer TERIA-S and biopreparation SERHOSIL on the accumulation of mobile forms of heavy metals in soils under winter wheat crops, adjacent fields of the Almalyk Mining and Metallurgical Combine of the Republic of Uzbekistan

(mg/kg, maturation phase, June, n=3, average for 2021-2022)

N	Experience options	Zn	Cd	Pb	Mo	Cu	Co	Ni	As	Cr
1.	Control, NPK	150,0	0,320	97,8	1,42	90,4	13,8	44,2	20,2	49,8
2.	Experience,NPK, treatment of wheat seeds with bacterial fertilizer TERIA-S and leaf treatment - 2 times during the growing season with biopreparation SERHOSIL	80,2	0,171	25,3	1,04	32,2	6,0	14,3	18,1	31,1
	MPC	**55,0**	**0,5**	**32,0**	**2,1**	**30,0**	**5,0**	**14,0**	**20,0**	**30,0**

Based on the complex application of bacterial fertilizer TERIA-S and biopreparation SERHOSIL we have developed a new environmentally friendly and cost-effective, resource-saving biotechnology for growing agricultural crops on medium and highly saline soils of the republic (Table 3).

Table 3

Influence of complex application of bacterial fertilizer TERIA-S and biopreparation SERHOSIL on crop yields on saline degraded soils (field trials, average for 2021-2022)

Agricultural essential culture	Yield, c/ha		Yield increase	
	Control, NPK traditional sowing	Experience, NPK TERIA-S + SERHOSIL	c/ha, t/ha	%
Cotton	25.0±0.7	34.0±1.5*	9.0±0.05	36.0
Sugar beet, t/ha	34.5 ±1.2	75.0 ±2.6*	40.5 ±0.4	17.4
Winter wheat	38,4 ±1.3	51.2±2.5*	12.8 ±1.3	13.3
Soya	22.1 ±0.6	34.1 ±1.2*	12.0 ±1.2	54.3
Potato, t/ha	41.5±0.5	46.7±1.3*	5.2±0.03	12.5
Tomatoes, t/ha	23.6±0.8	30.1 ±1.5*	6.5 ±0.4	27.5
Cucumbers, t/ha	19.0 ±1.2	22.5 ±0.6*	3.1 ±0.02	18.4

*P ≤ 0.05 - significant in relation to the control.

In field experiments under cotton, we studied the effect of new biotechnology on changes in the content of salts, humus and pH of soil solution in the arable soil layer around the root system of cotton (Fig.1, 2).

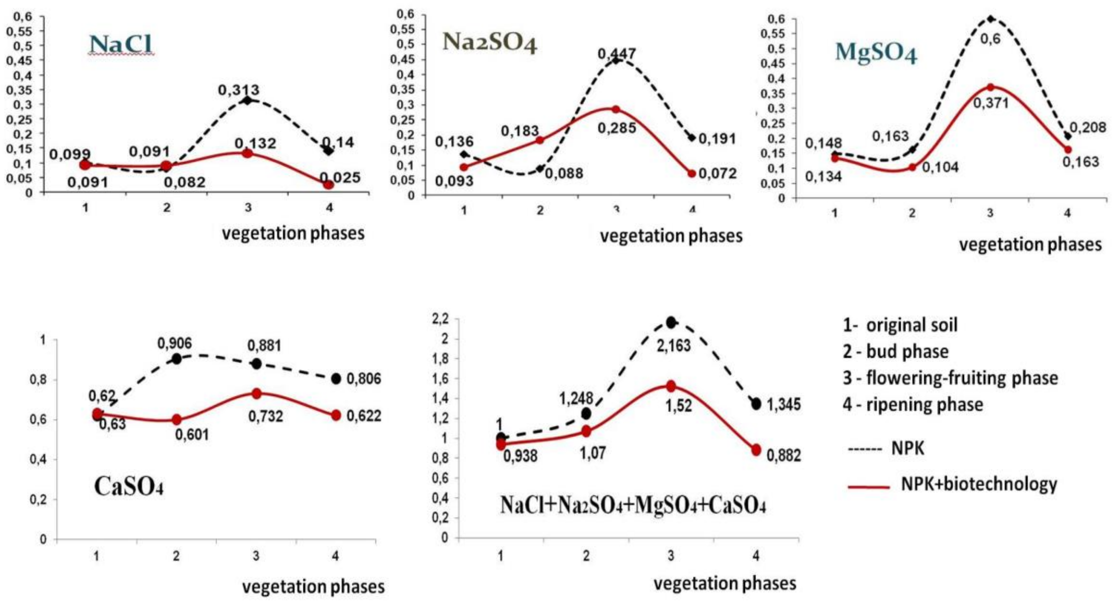

Fig.1 The influence of biotechnology on the salt content in highly saline soils during the growing season of cotton

From the data presented in Fig. 1, it can be seen that the use of new biotechnology for cotton cultivation on saline soils reduces the degree of their salinity of NaCl by 0,313%, Na_2SO_4 by 0,436%, MgSO4 - by 0,347%, CaSO4 – by 0,648%, and the amount of studied salts – by 1,346% on average during the growing season of cotton.

From the data presented in Fig. 2, it can be seen that the use of new biotechnology for cotton cultivation on saline soils reduces the degree humus content and changes in soil pH towards normalization.

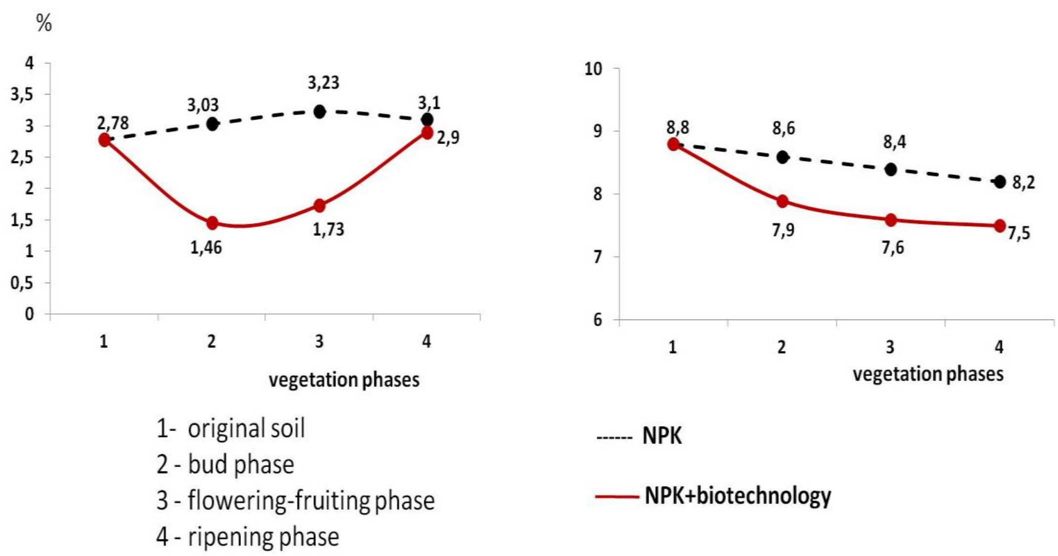

Fig.2 The influence of biotechnology on the dynamics in the hY and humus content of highly saline soils during the growing season of cotton

From the data presented in Fig. 2, it can be seen that the use of new biotechnology for growing cotton on saline soils reduces the degree of humus content during the growing season of plants and restores it again by the end of the growing season. This indicates that bacteria introduced into the soil together with seeds from the composition of the bacterial fertilizer TERIA-S break down humus substances into minerals and thereby improve the nutrition of plants with macro-microelements and changes the pH of the soil towards normalization.

Figure 3 shows the data of the field experience on the influence of biotechnology on the development of cotton on highly saline soils of the Syrdarya bransh of the Institute of Cotton Growing.

Figure 4 and 5 shows the data of the field experience on the influence of biotechnology on the development of wheat, root system, of the aboveground mass of wheat, the development of spikelets and wheat grains on highly saline soils of the Syrdarya region.

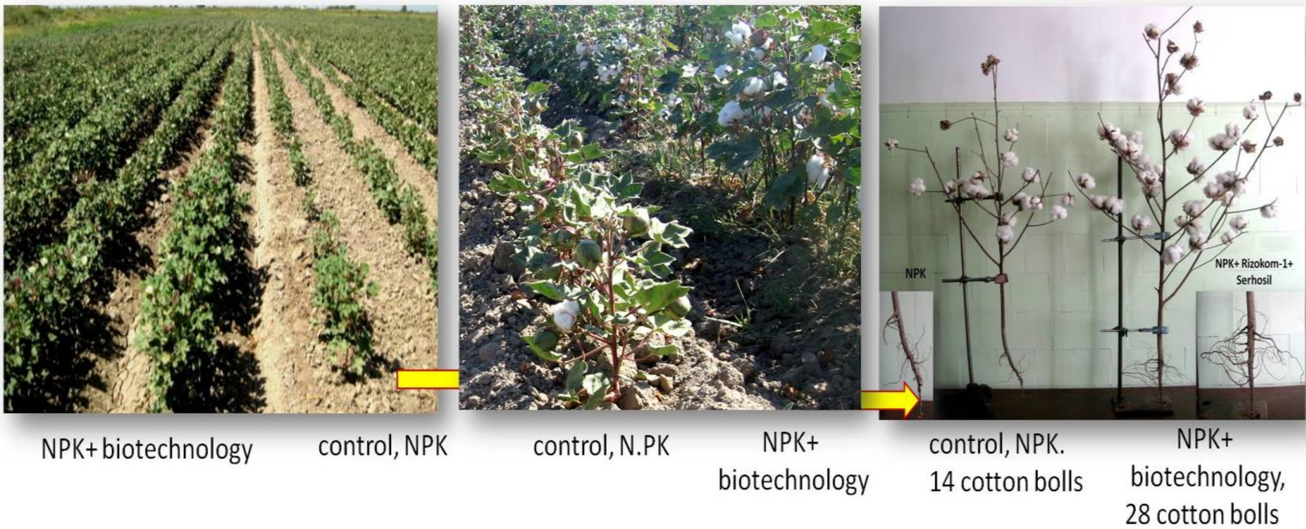

Fig.3 The influence of biotechnology on the development of cotton on highly saline soils of the Syrdarya bransh of the Institute of Cotton Growing

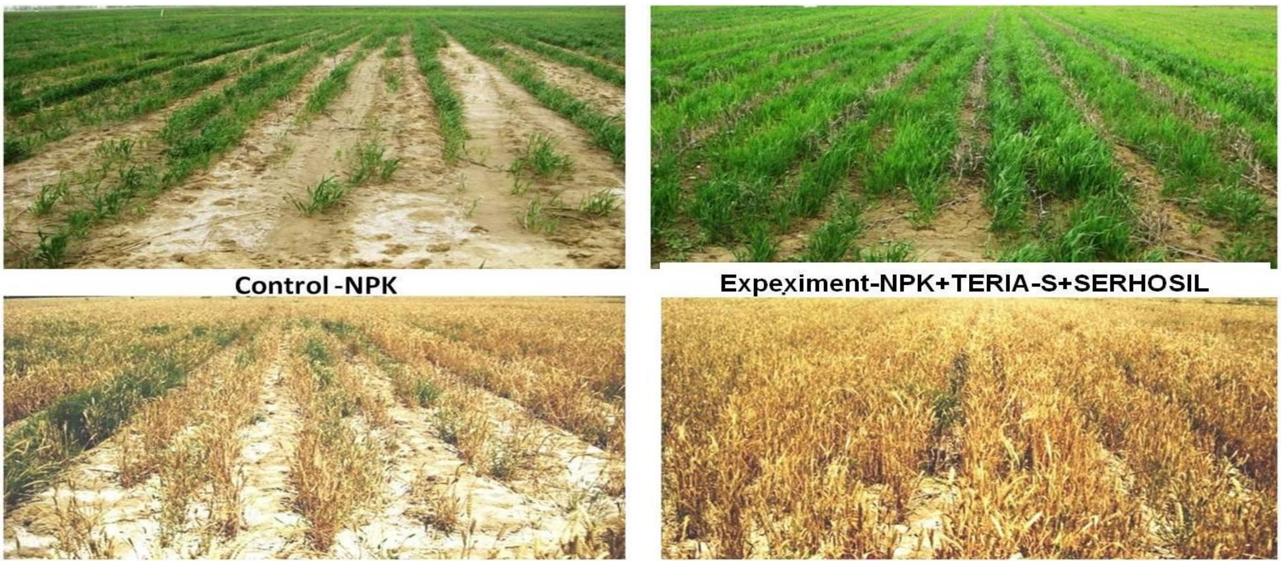

Fig.4 The influence of biotechnology on the development of wheat on highly saline soils of the Syrdarya region

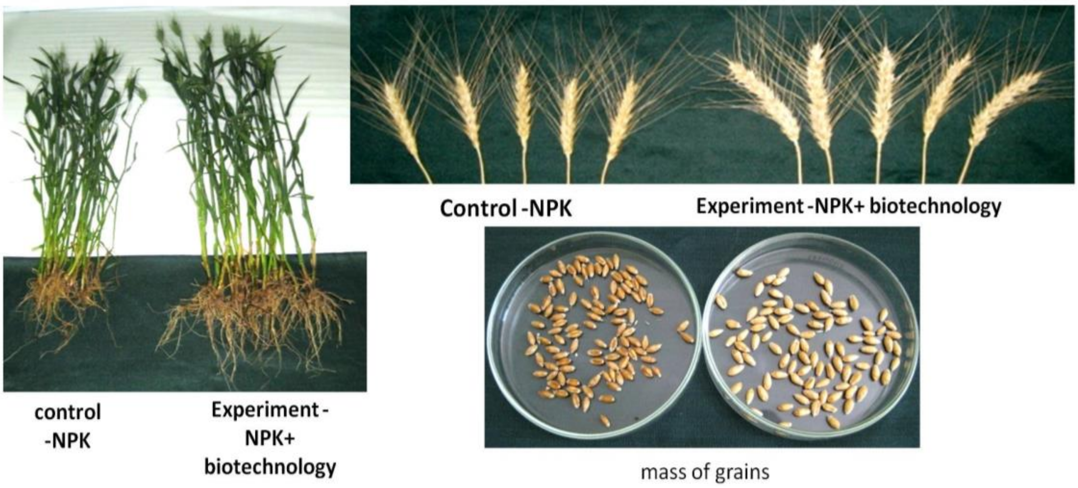

Fig.5 The influence of new biotechnology on the development of the root system of the aboveground mass of wheat, the development of spikelets and wheat grains on the highly saline soils of the Syrdarya region

Tables 4-7 present data on the yield of cotton and wheat on saline soils of the Republic of Uzbekistan with the use of new biofertilizers of complex action TERIA-S and SERHOSIL. Good data were obtained on increasing the yield of cotton by an average of 8.8-11.5 c/ha (27.4-53.1%) and wheat by 16.4 c/ha (27.8%).

Table 4

The use of bioagrotechnology on highly saline soils of Karakalpakistan

Region	**Farm**	**Year**	**Cotton variety**	**Cotton yield, c/ha**		**Increase in yield, c/ha**	**Increase in yield, %**
				control, NPK	**NPK+Teria-S+ Serhosil**		
Turtcul district	“Turtcul Agroclaster” LLC	2021	C-4727	12.0±0.6	30.0±1.5	18.0±1.0	25.0
Biruni district	"Fozilbek Komolovich"	2021	Sulton	20.0±2.7	40.0±1.7	20.0±2.1	100.0
the average				**17.0±0.7**	**28.5±2.6**	**11.5±1.0**	**53.1**

Table 5

Cotton crop of «Uztex Cluster» based cotton farms using bioagrotechnology in Khorezm region

Region	**Farm**	**Year**	**Cotton variety**	**Cotton yield, c/ha**		**Increase in yield, c/ha**	**Increase in yield, %**
				control, NPK	**NPK+ Teria-S+Serhosil**		
Shavat district	"Khudiyarov Amirbek"	2021	Khorezm 127	35.0±1.6	42.0±2.1	7.0±1.0	20.0
Shavat district	"Johongir Nur"	2021	Khorezm 127	10.0±0.8	25.0±1.4	15.0±2.0	50.0
Shavat district	"Koranbaev Omirbek"	2021	Khorezm 127	28.0±2.7	43.0±2.6	15.0±2.0	53.0
Shavat district	"Jomabaev Botir"	2021	Khorezm 127	26.5±1.7	32.0±1.5	5.5±0.05	20.0
the average				**24.8±1.5**	**35.5±1.6**	**10.7±1.2**	**43.0**

Table 6

The impact of new bioagrotechnology on the cotton crop on medium saline soils of the Fergana Valley

Region	**Farm**	**Year**	**Cotton variety**	**Cotton yield, c/ha**		**Increase in yield, c/ha**	**Increase in yield, %**
				control, NPK	**NPK+ Teria-S+ Serhosil**		
Namangan region, Tashbulok district	"Askarali ota"	2022	Andijan-35	35.0±1.6	48.0±1.7	13.0±1.3	37.1
Namangan region, Mingbulok district	"Aminjon ota"	2022	Andijan-35	30.0±0.8	42.0±2.1	12.0±1.2	40.0
Namangan region, Chust district	"Kholmat Zar zamini"	2022	Porlock-4	31.0±1.4	37.0±1.5	6.0±1.1	19.4
Andijon region, Shakhrikhon district	"Fakhrier baraka shodligi	2022	Sulton	32.0±1.5	40.0±2.2	8.0±1.2	25.0
Andijon region, Shakhrikhon district	"Mashal Ikbol Sakhovati"	2022	Andijan-35	35.0±1.7	42.0±2.1	7.0±1.0	20.0

Andijon region, Shakhrikhon district	"Yangi Tadbir"	2022	Andijan-35	32.0±1.5	40.0±2.2	8.0±1.2	25.0
Andijon region, Shakhrikhon district	"Abdu-vali"	2022	Andijan-35	32.0±1.5	40.0±2.2	8.0±1.2	25.0
the average				**32.4±1.6**	**41.3±2.1**	**8.8±1.3**	**27.4**

Table 7

The impact of new bioagrotechnology on the wheat on medium saline soils of the Fergana Valley

Region	**Farm**	**Year**	**Wheat variety**	**Wheat yield, c/ha**		**Increase in yield, c/ha**	**Increase in yield, %**
				control, NPK	**NPK+ Teria-S+ Serhosil**		
Namangan region, Tashbulok district	"Askarali ota"	2022	Alekseevich	50.0±2.1	60.0±2.8	10.0±1.0	20.0
Andijon region, Shakhrikhon district	"Fakhrier baraka shodligi	2022	Chillaki	60.0±2.3	80.0±2.8	20.0±1.8	33.3
Andijon region, Shakhrikhon district	"Mashal Ikbol Sakhovati"	2022	Alekseevich	60.0±2.3	80.0±2.8	20.0±1.8	33.3
Andijon region, Shakhrikhon district	"Yangi Tadbir"	2022	Alekseevich	60.0±2.3	80.0±2.8	20.0±1.8	33.3
Andijon region, Shakhrikhon district	"Abdu-vali"	2022	Chillaki	63.0±2.7	75.0±2.2	12.0±1.7	19.0
the average				**58.6±2.2**	**75.0±2.0**	**16.4±1.9**	**27.8**

Conclusion

Thus, based on the conducted scientific research and field tests and implementation on saline, degraded soils in the Syrdarya, Jizzakh, Bukhara, Namangan, Andijan, Fergana, Khorezm regions and Karakalpakstan, a new biotechnology on cotton on an area of 7,500 hectares and on wheat on an area of 2,500 ha, the following tangible 4 beneficial effects were identified:

1) resource saving effect:

- increase in the coefficient of digestibility of applied fertilizers;
- restoration and increase of soil fertility;
- increasing the field germination of seeds of agricultural crops on saline soils;
- reduction of seeding rates by 10-30%;
- reduction of irrigation water consumption by 30-40%.

2) economic effect:

- increase in productivity of agricultural crops by 12-54% and product quality;
- reduction of damage to agricultural crops by diseases and pests;
- increase of immunity, drought resistance and winter hardiness of plants;
- reduction of terms of ripening of agricultural products by 15-20 days;
- increasing the profitability of agricultural production up to 35-40%;
- increasing the shelf life of finished products in warehouses.

3) environmental effect:

- reduction of chemical load on the soil and agricultural crops;
- reduction of doses of chemical fungicides for dressing seeds;
- decrease in the degree of phosphatization, salinity, soil pollution with heavy metals, health improvement of soil environment.

4) social effect:

- improving the quality of agricultural products -reducing the content of nitrates in products, increasing the content of vitamins and useful macro-microelements
- improving the health of the population.

The developed new bioagrotechnology may well be used to manage the fertility of saline and degraded soils and the processes of plant nutrition. The soil becomes healthy, its productivity increases significantly.

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