

**USE BACTERIA FIXING NITROGEN IN TECHNOLOGY OF CULTIVATION
OF WHEAT**

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Abstract

The article presents results of the study of biological that are based on bacteria of the genus Azotobacter, their influence on the growth and development of wheat in Northern Kazakhstan. It is established that the use of nitrogen-fixing bacteria of the genus Azotobacter immobilized in sulfur zeolite, improves nitrogen-fixing capacity of soil to 21% and wheat yields in wet years on average to 4-5 h/h, and in dry conditions until 1 h/h.

Key words: *bacteria fixing nitrogen, grain crops, biological product.*

1. INTRODUCTION

One of the main functional components of the soil as the most difficult system are microorganisms occupying it. Character and intensity of biological circulation of substances, scale of fixing of atmospheric nitrogen, ability of the soil to self-cleaning depend on activity of microorganisms. Many microorganisms as the most important components of an ecosystem and the sensitive indicators of changes occurring in it which are using for biomonitoring of biological properties of the soil, are irreplaceable participants of formation of soil fertility and the catalyst of mineralization processes of organic substances which arrive to the soil in the course of cultivation of crops (Nauanova & Tchurkina 2007).

Numerical and specific structure of microscopic organisms of various soils differ big dynamism. The maintenance of bacteria, ray fungus and mushrooms in the soil doesn't remain to constants, it naturally changes depending on a number of factors: humidity, temperatures, cultivation of the soil, availability of nutrients, toxicity, antagonistic relationship in microbic cenosis, introduction of mineral and organic fertilizers. The number of microorganisms, and also their biological diversity substantially is defined by technology of processing of the soil and introduction of organic fertilizers (Lynch 1990). At favorable climatic conditions the quantity of microorganisms and their activity after soil fertilizer considerably increase, humus disintegration amplifies mobilization of nitrogen, phosphorus and other elements increases.

The intensification of agricultural production for the last half century, based on application of high norms of mineral fertilizers, led to exhaustion of natural potential and fertility of soils, worsened quality of water, air and agricultural production. Therefore ecologically balanced land use based on application of biological preparations comes to change to intensive land use. Now the problem of receiving essentially new preparative forms, capable to provide both protection of plants against causative agents of diseases, and a complex mineral food of microbic cages and a vegetable organism is very actual. One of such biological products is azotobacter, made on the basis of active strains of the nitrogen fixing microorganisms, providing a nitrogen fixation, control of development of pathogens, producing physiologically active agents. In this regard we created laboratory samples of a biological

product azotobacter on the basis of the new strains allocated from the southern carbonate humus of Northern Kazakhstan.

2. RESEARCH METHODS

As objects of research strains of soil bacteria from the sort Azotobacter (Az-1, Az-2, Az-3, Az-4, Az-5.), biological products created on their basis, wheat grade Astana 2, a mineral sulfur zeolite as a filler for a laboratory sample of a biological product served.

Field tests of experimental forms of a biological product azotobacter carried out on the basis of stationary experiences at S.Seifullin Kazakh Agro Technical University. On the anazotic liquid environment of Eshbi on shakers the biomass of 5 strains of an azotobacter, with continuous control of temperature, pH and availability of sugar is acquired. The caption of bacteria by a crops method in Petri's cups from 4, 5, 6, 7 cultivations is determined. The acquired biomass of bacteria was immobilized in structure sulfur zeolite. Before crops the inoculation of seeds of wheat in a dose of 200 g of a preparation on hectare norm of seeds was made. Crops of wheat of a grade Astana 2 were carried out on a sternal background on May, 25 by seeders of direct crops on depth of 5-6 sm. Norm of seeding of seeds of wheat of 2,5 million/hectare.

The accounting of defeat of plants root decay carried out to a phase of wax ripeness. For the analysis dug out on 25 plants from each frequency of a field experiment, intensity of defeat of grain crops root decay established on the 4th ball scale (Korshunova, Chumakov & Shchekochikhina 1976):

- 0 – symptoms of an illness are absent;
- 1 – on the basis of a stalk and its underground part brown strokes, spots (10% of a surface are struck);
- 2 – brown strips and the spots covering 50% for a surface of body;
- 3 – continuous becoming brown of the first stem and underground interstice;
- 4 – lack of productive stalks in the presence of symptoms on point 3.

The structural analysis of plants of wheat, the maintenance of nutritious elements and number of microorganisms in the soil it is carried out by the standard techniques.

3. RESULTS OF RESEARCH

For the purpose of influence definition of biological products on biological activity of the soil change of total number of microorganisms depending on types of biological products with the azotobacter immobilized in their structure in the southern carbonate humus of Northern Kazakhstan was studied.

Results of the conducted research showed (see Table 1) that in a stooling phase Az-3 immobilized in structure sulfur zeolite had positive effect of biomineral preparations on development of bacilli more. The number of the bacteria, acquiring organic nitrogen, on this option made 1,9 million/g soil. During the vegetative period the quantity of the bacteria acquiring organic forms of nitrogen, prevailed on options with application of biomineral preparations. Favorable conditions for reproduction of nitrogen uptaking microorganisms developed on options with application of an azotobacter of Az-1 and Az-2. Here the noticeable increase in the bacteria acquiring mineral forms of nitrogen that reflects high intensity of processes of transformation of fossils at which mineralization, probably, there is a shift towards bigger humification and formation of again synthesized organic compounds promoting restoration and increase of fertility of the soil is observed.

As the indicators reflecting agronomical value micro biocenosis, quantitative values of a ratio of number of microorganisms of various taxonomical groups are used. One of such indicators is the relation of number of bacteria to quantity of the fungus, called by a relative indicator of a bio hennosity of the soil (Tchernikov, Aleksakhin & Golubev 2000). Quite high bio hennosity is inherent in the southern carbonate humus, and in the cultivated soil it is higher, than in the virgin.

The maximum quantity of cellulose destructing microorganisms is noted on options with application of a strain of Az-1 that once again emphasizes stimulating effect of a biomineral complex on development and distribution of soil microorganisms in the soil.

Table 1. Influence of biomineral preparations on dynamics of number soil microorganisms.

Variant	Microorganisms in 1g of soil											
	bacterias, adopting nitrogen, mln.						fungi, thousands			cellulose destructing, thousands		
	organic			mineral								
	1	2	3	1	2	3	1	2	3	1	2	3
Control	0,6	0,4	0,5	4,0	2,8	6,6	2,5	3,1	4,3	4,7	28,6	-
Az - 1	0,9	0,8	1,5	13,6	9,0	12,3	5,2	3,8	4,1	7,0	86,2	-
Az - 2	1,6	0,7	1,8	6,5	2,2	9,7	2,7	6,4	7,6	4,2	26,3	-
Az - 3	1,9	1,2	0,6	5,5	4,0	7,6	2,0	5,7	6,0	5,3	47,0	-
Az - 4	0,8	0,8	0,5	9,2	3,4	8,5	3,4	3,8	5,4	3,6	21,6	-
Az - 5	1,6	0,9	1,6	11,1	5,6	13,0	1,2	5,2	3,9	5,3	27,2	-
Note: 1 – the first term of selection of soil samples during tillering period; 2 – the second term of selection of soil samples during flowering-earring period; 3 – the third term of selection of soil samples during period of complete ripeness.												

Development of an azotobacter in the soil, and also in a rhizosphere of plants happens in association to other representatives of soil micro flora who are very numerous and extremely various on the biological properties. Cohabitation of many microorganisms to an azotobacter is connected with use of the nitrogenous connections allocated by the last in environment, and also synthesis of physiologically active agents.

The quantity of microorganisms in a rhizosphere of plants is in direct dependence on level of a food, intensity of a metabolism, growth and age of plants. Root allocations of plants play an important role in development of an azotobacter, it uses them as the power supply, fixes atmospheric nitrogen due to organic substances allocated by roots.

Studying microbiological activity of the soil under wheat crops with biomineral preparations, made observations over accumulation of an azotobacter in the soil of experimental options. On options where cages of an azotobacter took root into structure of biomineral fertilizers, its quantity increased (see Fig.1).

Activity of nitrogen fixing bacteria of the sort *Azotobacter* in the soil of experimental options isn't identical during the vegetative period. In spring, by the time of full shoots of crops the *azotobacter* stirs up the activity. On options with application *azotobacter* this bacterium is found twice more often than on control. In a phase of flowering and full ripeness a biological product on the basis of *Az. chroococcum* Az-3 increased quantity of cages of an *azotobacter* by 1,5-2 times in comparison with control. In this case the *azotobacter* affects as a producer of biologically active agents stimulating microbiological processes in the soil and a rhizosphere, and also operating directly the highest plants.

The majority of researchers notes a change of number of an *azotobacter* depending on a phase of development of plants. However in the conditions of insufficient moistening the greater influence, than change of phases at plants has a mode of soil moisture.

Inoculation of wheat a biological product *azotobacter* NordKz promoted increase in number of the bacteria acquiring mineral forms of nitrogen, and also cellulose destructing fungus which strengthened processes of transformation of fossils, promoting restoration and increase of fertility of the soil.

We carried out analyses by definition of the content of the organic substance (humus), selected in crops of wheat, inoculated various strains of an *azotobacter*.

The maintenance of a humus in the soil under crops of wheat varied from 3,56 to 3,61%. Some increase in organic substance is noted on option with crops of wheat processed by a strain of Az-5, making 3,61 that is 0,06% higher than option without introduction of an *azotobacter*.

It can be explained to that in soil conditions mycolitical bacteria, eating mushroom myceliums, create cyclic connections like benzoic acid sodium which are the good power supply for an *azotobacter*. Finally, as a result of its activity humic similar substances, on the properties soils very close to humic substances are formed. Thus, the *azotobacter* developing in the conditions of the soil at the expense of products of disintegration of fungus, forms phaeochrous humus similar substances that speaks about its significant role in biogeochemical processes of the soil.

The carried-out analysis of the soil showed that the content of nitrate N-NO₃ nitrogen in the soil under crops increases at introduction of an *azotobacter* (see Fig.2).

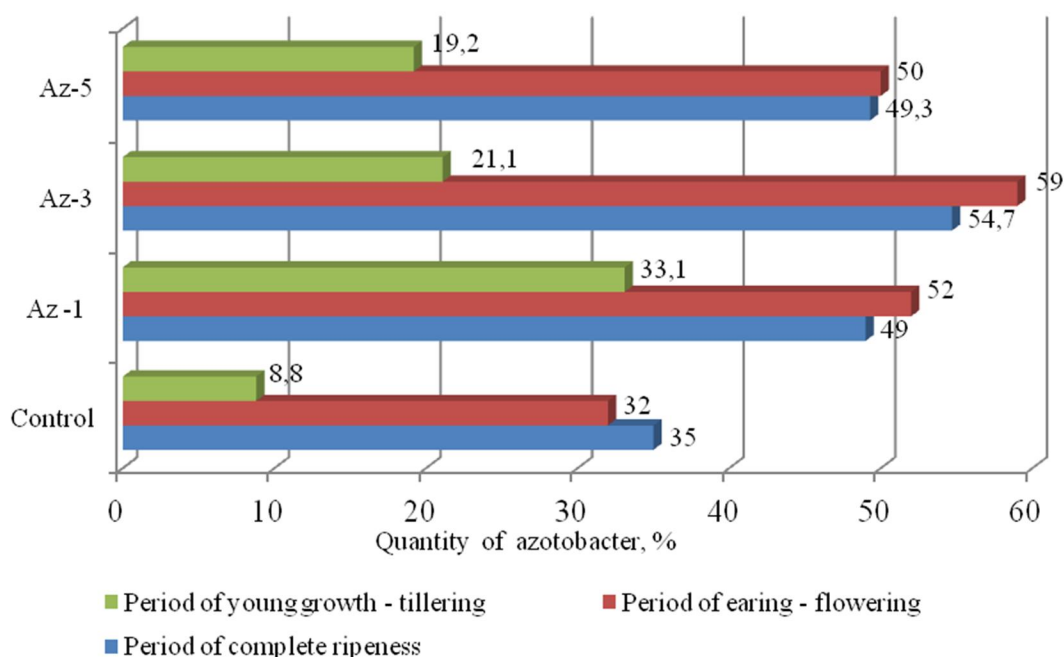


Fig.1. Survival of an azotobacter in a rhizosphere of wheat when using laboratory samples of azotobacter.

The maximum content of nitrate nitrogen is observed at introduction of an azotobacter Az-1 strain. During wheat maturing the content of nitrogen decreased on all experimental options, it is caused by carrying out of nutritious elements on crop formation. The high content of nitrogen in a phase earing-flowering is observed on option with application of an azotobacter of Az-4 in comparison with control. On level of security experimental options with introduction of biological products are characterized by mobile forms of phosphorus as average income. The content of phosphorus varies ranging from 21 to 27 mg/kg of the soil. By the end of the vegetative period the content of phosphorus remained high at the expense of additional intake of nutrients with biological products.

Action of biological products can be defined on accumulation by plants of nitrogen by a number of factors among which major importance belongs to security of plants with nitrogen which in turn depends on its fixing diazotrophs, and also enhancement of consumption by nitrogen plants from the soil as a result of microbe static effect.

The carried-out field tests allowed reveal efficiency of the received strains of the azotobacter possessing expressed stimulating effect on growth and development of wheat.

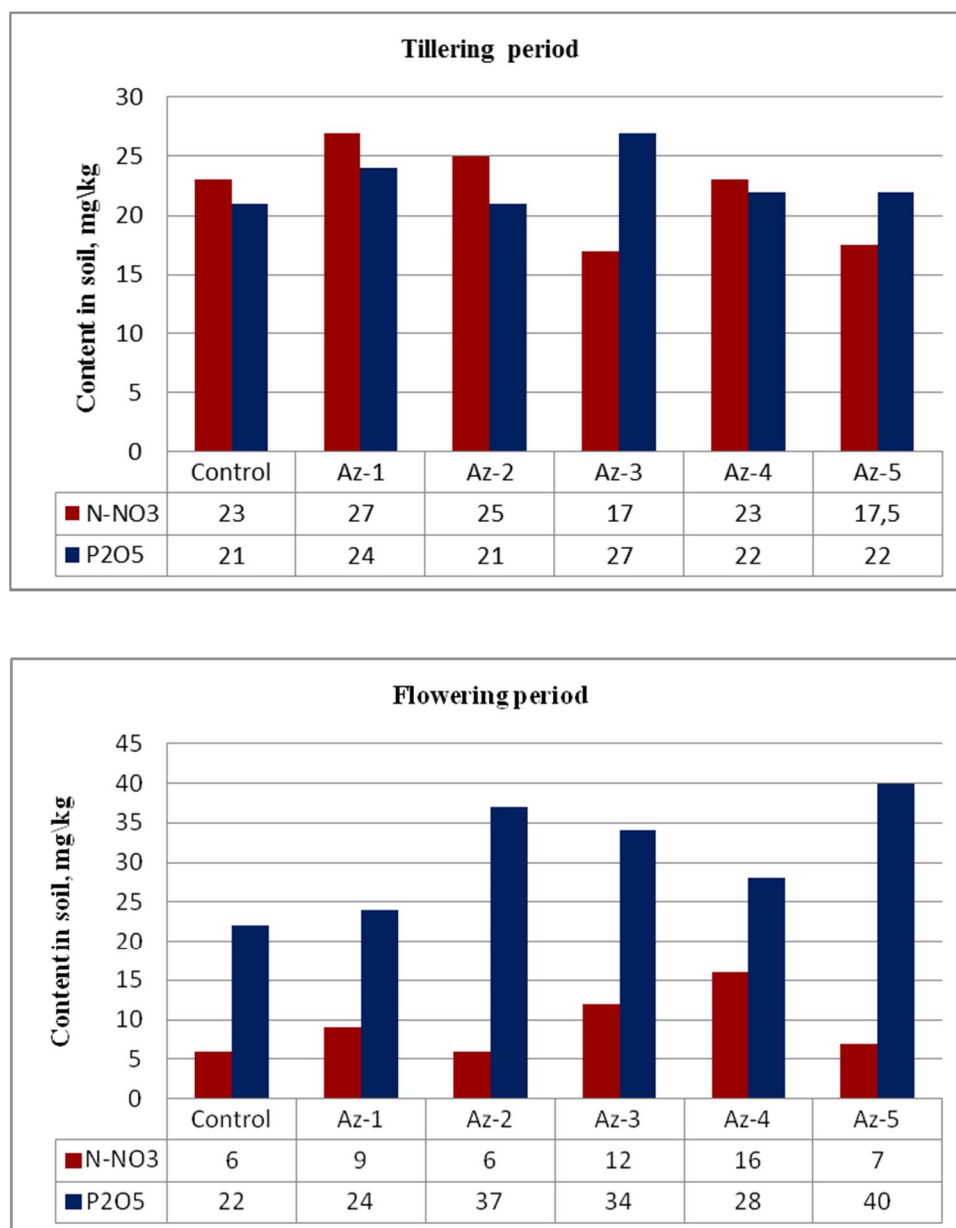


Fig. 2. The maintenance of nutritious elements on the southern carbonate humus under wheat crops against application azotobacter (in a layer of 0-20 cm).

Actions of azotobacter were studied not only on parameters of soil fertility, but their influence on efficiency of grain crops was also studied.

Results of the structural analysis showed that nitrogen fixing bacteria more positively influence safety of plants, number of grains in an ear, and also on the mass of 1000 seeds. Productivity of a spring-sown field depending on use of various strains of an azotobacter varied within 23,2 - 27 c/hectare (see Table 2).

The maximum level of productivity is observed on option with application of a strain of Az-2 and made 27 c/hectare. High productivity was observed and on option with application of a strain of Az-4 (26,1 c/hectare).

Increase of the most harmful disease of grain crops – root decay which annually reduces productivity of grain of spring-sown soft field by 20-23% is noted in Kazakhstan, thus in grain protein content decreases, quality of a gluten (Chulkin of et al decreases. 2000). The disease can be shown during the whole period of vegetation of plants, causing death of shoots, lag of plants in growth, a frail of grain and dying off of stalks (Sanin, Tcherkashin & Nazarov 2002).

Table 2. Change of elements of structure of a crop of wheat in connection with application of azotobacter.

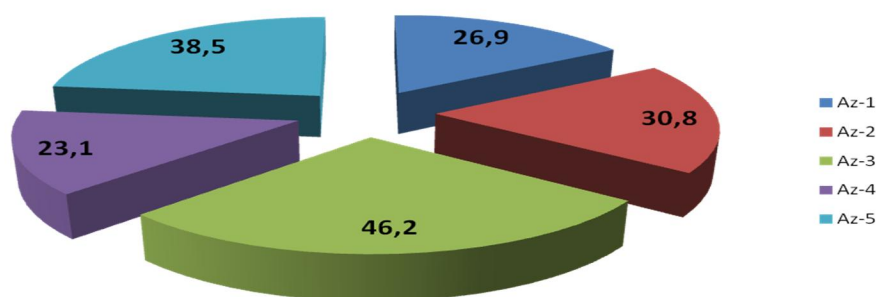
Variant	Productive bushiness	Plant height, sm	Ear length, sm	Number of grains in an ear, pieces	Mass 1000 of grains, g	Crop productivity, c/ha
Control	1,5	110	8,0	15	37,0	20,1
Az-1	1,5	110	9,0	18	39,0	23,5
Az-2	1,5	105	8,0	25	38,6	27,0
Az-3	1,7	110	9,0	30	39,5	25,1
Az-4	1,9	105	7,0	28	38,4	26,1
Az-5	1,6	102	9,0	26	39,8	23,2
HCP ₀₅	-	-	-	7,1	1,7	2,5

Suppression of root decay by chemical methods has a number of the restrictions connected with emergence of super persistent strains, and also with adverse ecological effects of application of pesticides in crops. Therefore, development of biological methods of protection of plants and increase of a suppression of soils concerning mushroom plant pathogenic (Sokolov, Monastic & Pokushova 1994) is actual.

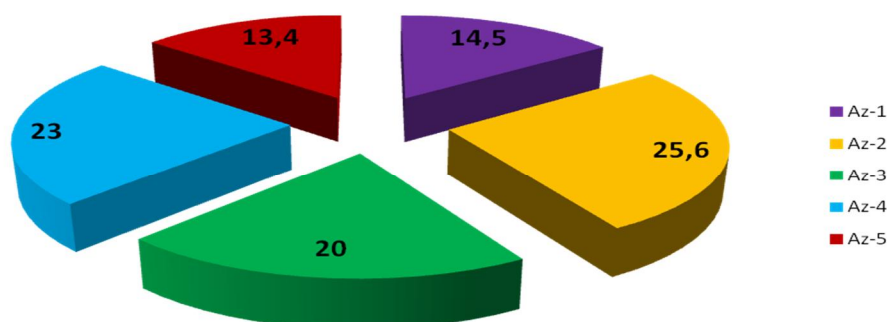
Use of nitrogen fixing bacteria for an inoculation of cultural plants is one of perspective agro technologies which can provide effective biocontrol of pathogens and by that to minimize use of pesticides and fungicides in agriculture. Azotobacter, producing anti fungal antibiotic substances, helps plants to raise and develop that has especially great value in early phases of their development (Terekhov & Yezhova 1997).

The greatest distribution and development root is noted by the decay on control option of 20,9% and 6,9% respectively. Favorable climatic conditions affected and growth of an azotobacter. Biological products on the basis of strains limited illness development on the average for 23,1-46,2% that led to growth of productivity of wheat on these options. Biological efficiency of the tested strains of an azotobacter against root decay quite high (see Fig.3). The highest biological efficiency is revealed on sites where seeds were processed by Az-3 and Az-5 strains. Economic efficiency of processing of seeds of wheat biological products on the basis of Az-2 and Az-4 was the highest, respectively – 25,6% and 23,0%.

The results of antagonistic and growth incitanting *Azotobacter chroococcum* properties received by us assume their further use in protection of plants against mushroom diseases. The biological product on the basis of a strain of Az-3 appeared the most effective in fight against mushroom diseases.



A



B

Fig. 3. Biological (A) and economic (B) efficiency of preseedling processing of seeds of wheat azotobacter.

4. CONCLUSIONS

For the first time biological products on the basis of strains of nitrogen fixing bacteria *Azotobacter chroococcum* immobilized in sulfur zeolite, allowing increase productivity in damp years on the average to 4-5 c/hectare are developed and tested.

Results of the conducted research testify that any of the tested biological products has no negative impact on crop formation.

Biological efficiency azotobacter against root decay averaged 35%, and economic efficiency of use of biological products - 20%. Decrease in development of a disease in wheat crops on the average for 44% and distribution restriction - for 32% is established.

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