# INFLUENCE OF BIOFERTILIZERS ON SOWING QUALITIES OF SOYBEAN AND WHEAT SEEDS

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Abstract: Preparing the seed material, as well as choosing the right protectant, is an opportunity to prevent the disease from developing in the field and to get good healthy sprouts. In the laboratory conditions, the effect of growth stimulants and thiram protectant on the seed microbial flora and the sowing quality of soybean and wheat seeds was evaluated. As biofertilizers, sodium humophosphate and potassium humophosphate were selected as growth stimulants, thiram FS (suspension concentrates for seed treatment) was taken from the protectants, which has a wide spectrum of action against fungal and bacterial infections. They were tested separately and in combination with a protectant in recommended doses. Preliminary phyto-examination of seeds, conducted according to methodological instructions, showed their infection level with fungal and bacterial microbial flora. The purpose of our research was to use as biofertilizer growth promoters - sodium humophosphate and potassium humophosphate and assess their effect on the sowing qualities of soybean and wheat seeds.

Keywords: Soybean, wheat, infection, biofertilizer, protectant, effectiveness.

## 1 Introduction

The agricultural sector of Kazakhstan in recent years has faced a number of serious problems. To solve them, the Government of Kazakhstan has developed the Program for the Development of the Agro-Industrial Complex of the Republic for 2013-2020 "Agrobusiness 2020", the main goal of which is to increase the competitiveness of agricultural products.

The high quality of seeds is one of the main agronomic requirements, ensuring, under other optimal conditions, the production of high and stable crop yields.

Seeds are a source of conservation of many disease excitants, as they are rich in proteins, minerals and represent a good nutrient substrate for pathogenic fungi and bacteria livelihood.

Disease excitants that persist in the seed grains to significant crop losses and a decrease in grain quality due to:

- reducing the germinating ability of seeds (loose smut of wheat and barley);
- death or damage of the root system of sprouts (Fusarium and Helminthosporium root blights, Alternaria blight, bacterial blight), which leads to the deterioration of crops;
- contamination with mycotoxins (fusariosis);
- reducing the number of productive stems (dusty and hard cereal crops, Fusarium root rot and others).
- mycotoxins infection (Fusarium blight);
- decreasing of the number of productive stems (loose and kernel smut of cereal crops, Fusarium root blights, and others).

In addition, sprouts and primary roots have tender tegmen through which easily penetrate causal agents that persist in the soil. (1-3)

Among the leguminous crops, soybean is characterized by a high content of principal nutrients. Its seeds contain up to 50% protein and 20% oil, as well as minerals and vitamins, which allows it to be used for food, as well as for technical and fodder purposes. Its importance in increasing the fertility of the soil is also great. The arable layer of soil is enriched with organic nitrogen by means of nodule bacteria. In addition to that, soybean is a good precursor for many crops. The diversification of agriculture carried out in the country predetermines the increase in soybean production by means of the expansion of sowing areas, the increase of the yield of this valuable crop, the reduction of yield losses from pests, especially from fungal and bacterial diseases.

Getting high and stable soybean crops largely depend on the quality of the seed grains. In the practice of agricultural production, increasing attention is paid to the use of growth stimulants. The need for seed treatment with growth stimulants is now a scientifically grounded method. (4) Herewith, it is possible to achieve maximum germination ability and germinating energy, as well as the reduction of environmental factors and to improve the quality and quantity of obtained products. (5)

A very popular culture is wheat, from which flour is made, which, in turn, is the most popular product. Bread and various bakery products are produced from wheat flour. Such foodstuffs are purchased daily by millions of people. For farmers involved in the cultivation of cereals, it is important to have a quality and safe growth stimulant for wheat. A good growth stimulator for wheat will accelerate the process of plant development, and will also strengthen its health and resistance to various diseases. In addition, the growth stimulator significantly affects the quality and quantity of the crop. Therefore, many entrepreneurs engaged in agricultural activities acquire a highly effective and quality growth stimulator for crops. However, most of them are not able to effectively suppress the seminal infection. At the same time, seed disinfectants, in most cases, suppressing the seminal infection, do not have a positive effect on the germination ability, growth, and development of plants. The co-use is necessary for increasing their effectiveness. The combination of these two means of protection will allow developing an effective way of processing seeds. (6-8).

## 2 Materials and Methods

The objects of research are soybean and wheat seeds, biofertilizers. Research methods - the effect of soybean and wheat seed on sowing qualities of seeds and microbial flora was carried out under laboratory conditions. The sowing qualities of the seeds were determined in wet chambers placed in a thermostat at a temperature of 24°C. The germinating energy was taken into account on the 3rd day after the trial establishment was laid, the laboratory germination ability on the 7th day in terms of the number of sprouted seeds. The processing effect on bacterial and fungal infection of seeds was established on nutrient medium with potato dextrose agar (PDA). Herewith, the absence of microbial flora around the seeds was noted - (-), weak growth (+), medium (++), intensive (+++).

One of the most widely used for food, fodder and technical purposes is leguminous crop - soybean. The most important component of this culture is protein and fat. Soybean as a source of high-quality amino acid content of protein used for food purposes, as well as for valuable vegetable oil, which has food and technical applications, is in great demand. Soya, in comparison with other legumes, is not only richer in chemical composition, but also has the highest feed value, which has contributed to the development of the grain-growing direction of its cultivation and, in turn, made it possible to widely use it in fodder production as a culture providing more concentrated ingredients for formula feed industry.

One of the main reasons for the low yield of soybean and wheat is the lack of necessary nutrients for plants. Virtually any stress factor leads to a disturbance in plant nutrition - drought, low or high temperature and soil or air compactness, soil compactness and poor aeration. That is, even with a sufficient number of fertilizer elements in the soil, plants are not always able to use them fully. (9)

At present, close attention is paid to humic substances, which constitute a specific group of high-molecular compounds. This is due to the fact that they are economically the most profitable raw material for obtaining humic preparations. The latter contain

biologically highly active humic acids or their salts. They stimulate the growth processes of plants in the initial phase of development. But the intensity of manifestation of this action is different not only within families and genera but also between individual varieties and even hybrids of a variety of the same species. The most widely known drug is sodium humate or potassium humate.

The use of sodium humate for presowing seed treatment is an indissoluble part of measures to increase the yield of crops, in particular soybeans and wheat. Sodium humate increases the activity of many enzymes and enzymatic systems in the plant organism and improves the use of plant nutrients from soil and fertilizers. Great role of the drug in increasing the quantity and quality of the crop, in a favorable effect on the state of plants and the environment.

In 2012-2014, research was conducted on the territory of the scientific-experimental farm "Agrouniversitet" of the Kazakh National Agrarian University aimed at identifying ways to obtain high yields of soybean culture, using plant protection products and various biological products that can reduce the number of mineral fertilizers used. This is largely due to the fact that in modern agriculture, the fertility of soils should be considered not only in terms of plant nutrition but also with the preservation of the ecological functionality of the landscape. Anthropogenic load affects the fertility of lands, therefore, the problem of complex application of fertilizers with plant protection products and biological preparations of different directions of action, which ensure high crop productivity in crop rotation, is important for research, raising the state of soil fertility. (10-11)

The data of scientific institutions show that fertilizers are an effective and fast-acting factor that contributes to improving the quality of the crop. With the help of fertilizers, you can change the direction of metabolic processes in the desired direction, increase the accumulation of proteins, fats and other substances in plants, influence the chemical composition of plants, which determines the quality of the crop.

Therefore, it is important to know the conditions for the effective use of fertilizers, not only to increase the yield, but also to improve the quality of the produce.

The main substances that determine the nutritional and fodder value of soybean are proteins. Important in soybean seeds is fat. The chemical composition of soybean grain consists of protein 39%, starch 3%, fat 20%, fibre 5%, sugars 10% and ash 5.8%. Proteins in soybean seeds are on average 2-3 times more than in seeds of cereals.

This indicates that with equal yields from the same area, you can get 2-3 more proteins than when sowing cereals. The soy straw also contains many proteins. The study of the protein complex of soybean seeds showed that globulins predominate in it. They account for more than 60-70% of the total protein content. Proteins of soybean seeds were almost completely dissolved in water and in a 10% solution of sodium chloride. The easy solubility of proteins in water and solutions of neutral salts means easier digestibility for humans and animals, which distinguishes soya from the seeds of cereals. (12)

The biological value of proteins of soybean grain is very high, it is much higher than the biological value of other vegetable proteins. If we take the biological value of milk proteins for 100, the value of soy proteins approaches 100, other legumes to 75-85, rice to 83, wheat to 62. There is evidence that the proteins of milk and soybean are equipollent. In soy protein, there are all essential amino acids. Thus, soybean seeds are not only a product with a large number of proteins but also a concentrate of easily accessible amino acids for humans and animals.

The quality of seeds is the most important factor determining the size of the crop. The seed is the bearer of the biological and managemental signs of the future harvest. For sowing, it is necessary to use high-quality seeds of recognized and appreciable varieties. One of the main indicators affecting the quality of seeds is the level of technology for their cultivation. The higher are the arable farming, the agricultural background, the higher is the yield and the better is the quality of the seeds. (13)

The use of bio preparations in crop rotations promotes additional accumulation in the harvest of basic nutrients from fertilizers and an increase in the coefficient of their use by a factor of 1.5-2. The seed inoculation with microorganisms increases the accumulation of biological nitrogen in the crop by a factor of 2.3-6.5, reduces the tension of the balance of this element, and ensures an increase in the supply of stubble-root remains to the soil, due to screefing of which in the arable layer, accumulate up to 1.2 ... 1.4 t/ha of humus.

Grain quality is a combination of the biological, physicochemical, and technological properties of a grain, which determine its suitability and ability to satisfy certain needs in accordance with its purpose. The quality of wheat is a factor of intensification of agricultural production, therefore, the improvement of biochemical indicators of products is of key importance in the agriculture and crop production. (14)

Germination ability is the number of normally germinated seeds, denoted as a percentage of the sample, which was taken for analysis. Seeds that have a root not less than the length of the seed and a sprout not less than half the length of the seed (rye, wheat) refer to well sprouted. Among the germination ability, the distinction is made between laboratory (rationed by the standard) and field. (15)

Laboratory germination ability determines after germination of seeds for 7-8 days in a thermostat in specialized germinators that are filled with heat-treated sand, or Petrie dishes, the bottom of which is paved with moistened filter paper, at a temperature of 20 ... 22 °C.

Field germination is determined by the number of emerged sprouts, expressed as a percentage of the number of seeds sown. Since it is impossible to create the necessary conditions in the field, as in the laboratory, then the field germination is usually somewhat lower than the laboratory one. On average, the field germination is 60-70% for cereals, 35-70% for beets, 36-60% for perennial grasses.

The germination ability and energy of seed germination are important indicators of their sowing qualities. Seeds with high germination ability and good germination energy with proper agrotechnics always give vigorous and full-fledged shoots. Germination ability of seeds has a high production value: it determines their suitability for sowing, the seeding rate. (17)

The standard for certified and sowing qualities of seeds makes high requirements to the norms of germination ability. Seeds that do not fit the requirements of the standard are forbidden to use for sowing. When sowing seeds with low germination ability, the yield decreases; such seeds are inexpedient to use.

Germination energy is the germination rate, which is expressed in percent of seeds germinated (given roots, equal to half the length of the seed, and sproutings) in terms established by experimental germination. For field crops, it ranges from 3 to 15 days.

The germination energy is affected by a huge number of factors: heavy metal salts, growth stimulators, seed damage, etc. The most relevant factors are plant growth stimulators. Growth stimulants are substances that stimulate or inhibit the processes of growth and development in plants. They can be of both natural origin and artificially synthesized.

The mechanism of action of stimulants on a living organism can be varied. Stimulants can affect:

1. biosynthesis, translocation and accumulation of natural phytohormones in the plant;
2. the rate of oxidation-reduction reactions;
3. cell division, their extension, etc.

Herewith, any of the stimulants, as a rule, acts on a certain part of the metabolism and, accordingly, can be used in strictly defined cases.

Stimulants differ in the rate of manifestation and the duration of their action, which also depends on the size and culture of the plant, the amount of active ingredient and the time of its decomposition or inactivation. (18)

It should be noted that with an increase in the concentration of the stimulant and the time of its effect on the plant, the stimulating effect, as a rule, becomes oppressive (inhibitory). Therefore, the search for the most effective way of applying a certain stimulant in practice requires considerable time, effort and money from scientific institutions with further correcting in the conditions of agricultural production.

Organic waste of livestock complexes and processing industry are already fertilizers. However, the efficiency factor of such fertilizers is only 10-15% of the possible. When processing these wastes on a biogas plant, there is a significant improvement in their properties.

In supporting the ecological balance in soils, the most important role is played by the resource of humus, which is a nutrient medium for soil-forming microorganisms that stimulate the nutrition of plants and their growth processes. (19)

The basis of humus is the remains of organics of vegetable origin: the least decomposed fractions, the fractions that continue to decompose, the complex substances that formed as a result of hydrolysis and oxidation, and substances that are the result of the vital activity of microorganisms.

Humus includes humic acids, fulvic acids, and salts of these acids, as well as humins - stable compounds of humic acids, fulvic acids with ground materials. Humins have a significant specific surface area (600-1000 m2/g), a large adsorption capacity. When a small amount of humus is introduced into the soil (20), compared with other fertilizers, the composition, and structure of the microbial flora changes. This, in turn, leads to a change in the microbiological regime in soils, the intensification of the processes of the transformation of substances and energy. As a result, metabolic processes are accelerated, new cycles of microbial flora development are included, in particular, the activity of nitrogen-fixing bacteria is increased. As a result, the nutrient medium is enriched.

The soils in which humic fertilizers are contributed are characterized by the following characteristics:

- the mobility of ground phosphorus increases;
- the processes of nitro formation in the soil are activated, which in turn contributes to a significant increase in total and protein nitrogen, an increase in the release of carbon dioxide by the soil;
- accumulation of ammonical and amidic forms of nitrogen, phosphorus in plants are accelerated;
- the concentration of potassium and aluminum increases with a decrease in the amount of magnesium, i.e. humates exert a significant influence on the content and dynamics of ground cations.

In all important processes of soil formation and formation of soil fertility, humic substances actively participate, which are the result of the decomposition of organic substances. The main indicator of the humus state of soils is the content of organic matter, as it substantially improves the physical, chemical and biological properties of the soil promotes fertility. Also, organic substances have a low thermal conductivity and prevent the rapid release of heat from the soil into the atmosphere. (21)

Humus is 15-20 times more effective for any organic fertilizer. Specific microbial flora and enzymes that are contained in humus, a way to resume "dead soil", i.e. to ensure all its functions and give it the properties of high fertility. These valuable properties of humus retain for 3-4 years.

Annually, simultaneously with the crop, a large amount of organic material is taken out, the number of living microorganisms decreases, and as a result, the activity of humification is reduced. To maintain the necessary level of humus in soils, organic fertilizers (pus, poultry litter, peat) are most often introduced, but the content of humic substances in such organics is very small. Therefore, for a minimum provision of soil with the necessary amount of humus, it is necessary to use more effective fertilizers. (22)

When using humus, a significant increase in the quantity and quality of the crop is achieved. For example, according to different sources (23), winter wheat gives an increase of 15-20%, sugar beet up to 20%, corn 20-30%, potatoes - up to 30%. Thus, the positive effect of humus on soil fertility and yield can be represented in the form of a complex of interrelated processes:

- the physical, mechanical and physical properties of the soil improve;
- the processes of soil exchange are intensified: the adsorption of soil nutrients by fertilizers with the improvement of the nutrient regime of plant development and the increase of biological activity. As a result - yield enhancement.

Along with the stated signs, humus also has other properties, such as high moisture capacity, moisture resistance, the mechanical strength of granules, absence of weed seeds, the presence of a large number and wider range of useful microorganisms, enzymes, antibiotics, growth-promoting hormone for plants. Humus also has more standard qualities: flowability, controlled humidity, the processability of use, the predictability of action on crop yields, harmlessness to the soil, good interaction with these or other mineral and chemical fertilizers. In combination with meliorative and structuring properties of soil, such organic fertilizer, produced by natural technology in industrial production, exceeds the competitiveness of any other artificial mineral fertilizers. (24)

Liquid biofertilizers can also be used for non-root dressing (spraying) of plants. Spraying effectively acts against some harmful insects that parasitize on fruit-berry plants.

### 2.1 Advantages of Biofertilizers Over Other Organic Fertilizers

Biofertilizers are many times better than other organic fertilizers (pus, poultry litter, peat). Here are some of them:

- Lack of seeds of weeds. In the pus of pigs, cattle, and peat, there is usually a large number of weed seeds. In 1 ton of fresh pus, there are up to 10 thousand seeds of different weeds, which, after passing through the stomach of animals, do not lose the ability to germinate. This leads to a loss of harvest from 5-7 centners of cereal crops per hectare.
- The absence of pathogenic microbial flora. Organic fertilizers often spread many plant pathogens. For example, pus can contain more than 100 diseases that are dangerous to animals and humans: anthrax, tuberculosis, brucellosis, paratyphoid fever, paratuberculosis, foot and mouth disease, salmonellosis, ascariasis, and intestinal infections are just some of them. Pork pus has a total microbial contamination from 4.1 to 3.610-9, sporous anaerobes from 10-2 to 10-4, coli titer ranges from 10-5 to 10-7. Biofertilizers, thanks to a special processing technology in a biogas plant, are completely disinfected from pathogenic microbial flora.
- The presence of active microbial flora, which contributes to the intensive growth of plants. Organic waste that is used as a fertilizer does not have or contains a small amount of microbial flora. The pus contains 109 colonies/gr n different microbial flora, including undesirable. Biofertilizers contain 1012 - 1014 colonies/gr n microbial flora, while undesirable microbial flora is completely absent.
- Lack of adaptation period. Pus and other organics require long-term preparation (6-12 months) before soil application. Useful substances that are contained in them are partially lost, and the rest take effect in the soil only for 2-4 years

after its application. Due to their shape, biofertilizers begin to work effective immediately upon application. (25)

- Resistance to the removal of nutrients from the soil. For a season about 80% of organic fertilizers are washed out of the soil, therefore it is necessary to add them annually in large quantities. During this time, only up to 15% of biofertilizers are washed out of the soil. Thus, biofertilizers' applications in a small amount to your fields will work for 3-5 years longer than conventional fertilizers.
- Maximum preservation and accumulation of nitrogen. An insufficient amount of nitrogen in the soil leads to a decrease in the yield of many agricultural crops. At the same time, the effective growth of plants is hindered, their resistance to various diseases is weakened. Prolonged nitrogen starvation leads to the hydrolysis of proteins and the destruction of chlorophyll. With long-term storage (composting) of organic waste, up to 50% of nitrogen is lost. In biofertilizers, due to the anaerobic fermentation of organic waste in a biogas unit, the amount of total nitrogen N will be fully preserved, in addition, the content of soluble nitrogen Nh4-n increases by 10 - 15%.
- Ecological impact on the soil. Organic fertilizers in non-processed form cause more damage to the soil, polluting it and groundwater. Whereas biofertilizers are absolutely pure ecological fertilizers.

**2.2 Advantages of Biofertilizers in Comparison with Mineral Fertilizers**

Mineral fertilizers have a negative impact on human health and soil. Mineral fertilizers in the form of granules or solutions are absorbed only by 35-50%, the rest is lied over in the form of nitrates in products and soils. In turn, grown foods have a bad effect on the human body. Nitrates promote the development of cancerous tumors in the gastrointestinal tract. Long-term intake of nitrates in small doses leads to an increase in the thyroid gland. Nitrates contribute to increase cholesterol and reduce protein in the blood of humans and animals. (26)

Biofertilizers due to their biological properties are digested by plants almost 100%, while the content of nitrates in products is minimal.

**3 Results and Discussion**

Preparation of crops seeds for sowing should begin with the obligatory carrying out of a phytopathological examination of seeds, which includes microbiological analysis of the composition of fungal and bacterial phytopathogens. The purpose of our research was to use as biofertilizer growth stimulators - sodium humophosphate and potassium humanosphere, to evaluate their effect on the sowing qualities of soybean and wheat seeds.

Table 1. Effect of a Combination of Biofertilizers with a Protectant Thiram FS on Sowing Qualities and Microbial Flora of Soybean Seeds (Laboratory Experiment, 2018)

| Characteristics | 2007 | 2008 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| Sector's share in global GDP, % | 3,2 | 2,9 | 4 | 5,3 | 7,4 |
| Share of world experts in global exports, % | 10,9 | 7,7 | 13 | 15 | 20 |
| Sector value of world exports, bln/year | 1483 | 1242,4 | 1460,5 | 1682 | 2500 |
| Sector output in the world, bln/year | 2134 | 2044 | 3500 | 4200 | 6800 |
| Consumption, % | 6,1 | -4,2 | growth rate of over 4,4% per year | | |
| Consumption, % | 6 | 2 | growth rate of over 3,6% per year | | |

As a result of preliminary phyto-examination of soybean and wheat seeds, conducted according to the guidelines (20), a high level of their infection with saprophytic and pathogenic microbial flora was established. In this regard, biofertilizers were tested separately and in combination with a protectant, which has a broad spectrum of action against fungal and bacterial infections (23). All drugs were used in recommended doses. In control, the seeds were treated with water.

As can be seen from the results presented in Table 1, the treatment of soybean seeds with biofertilizers increased the energy of seed germination but did not restrain the growth rate of fungal and bacterial microbial flora.

1 2 3

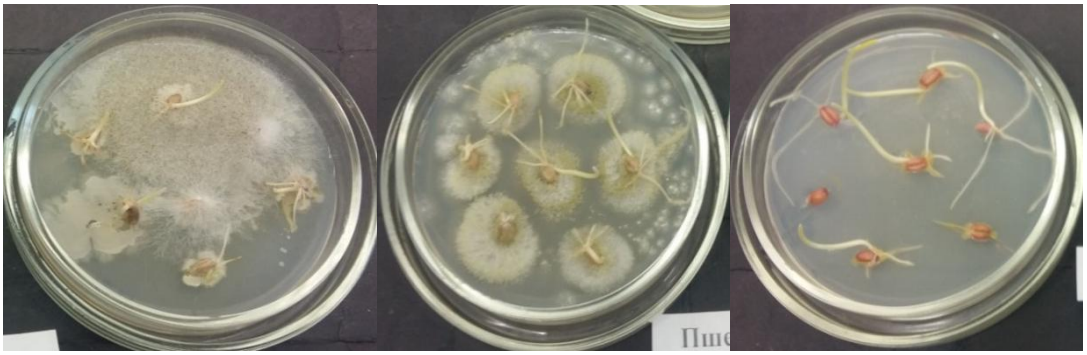

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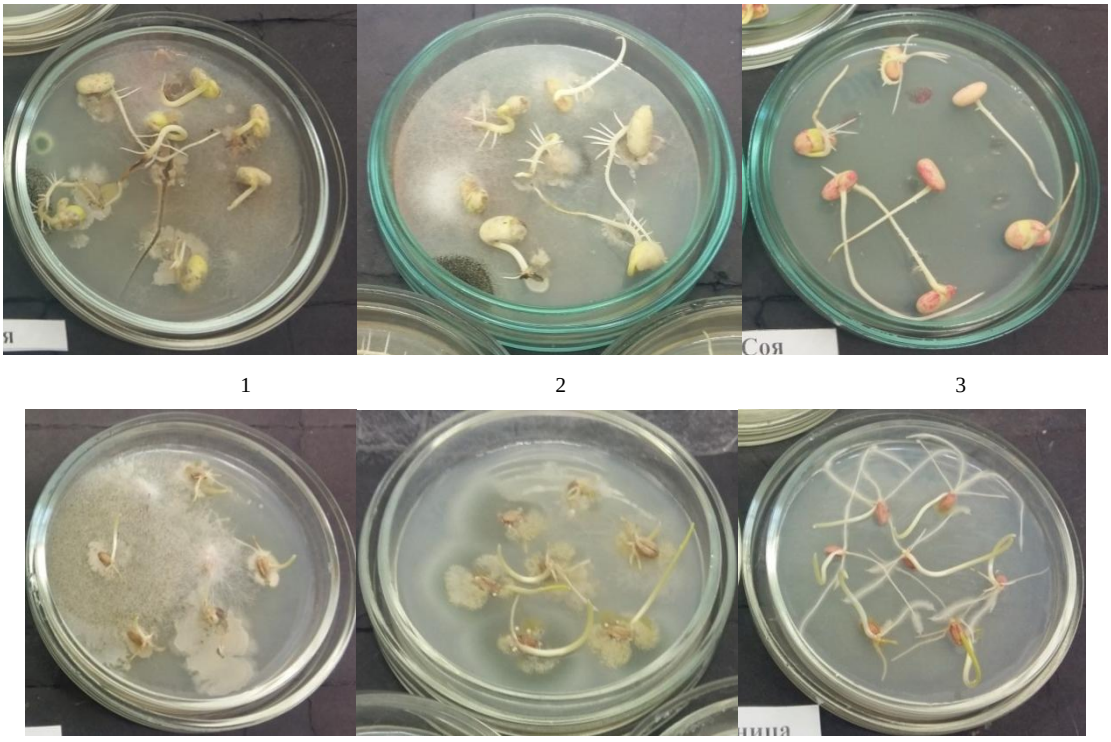
Figure 1. The Growth of the Microbial Flora of Soybean and Wheat Seeds After Treatment (Growing Medium) With 1 - Water, 2 – Sodium Humophosphate, 3 – Sodium Humophosphate + Thiram Protectant



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1 2 3

Figure 2. The Growth of the Microbial Flora of Soybean and Wheat Seeds After Treatment (Growing Medium) With 1 - Water, 2 – Sodium Humophosphate, 3 – Sodium Humophosphate + Thiram Protectant


Figure 3. Dependence of the Degree of Water Treatment on the Concentration of Oil (m (GKM) - 1,0 m.p., t - 30 min, T - 20°C)

By a combination of biofertilizers with a protectant, suppression of the seminal infection and a significant increase in germination energy, stimulation of plant growth and root system are noted (Figures 1-4).

Table 2. Effect of a Combination of Biofertilizers with a Protectant Thiram FS on Sowing Qualities and Microbial Flora of Wheat Seeds (Laboratory Experiment, 2018)

| Variants | Sowing qualities of seeds, % | | The intensity of microbial flora growth | |
|---|---|---|---|---|
| | germinating energy, % | laboratory germination ability, % | fungal | bacterial |
| Control | 64,5 | 93,5 | +++ | +++ |
| Sodium humophosphate | 74,2 | 96,2 | ++ | ++ |
| Potassium humanosphere | 71,0 | 95,5 | ++ | + |
| Thiram + Sodium humophosphate | 88,5 | 97,0 | - | - |
| Thiram + Potassium humanosphere | 84,5 | 96,5 | - | - |

According to the results of Table 2, it is evident that when processing wheat seeds with biofertilizers, the seed germination energy rises, and the growth rate of fungal and bacterial microbial flora is not restrained.

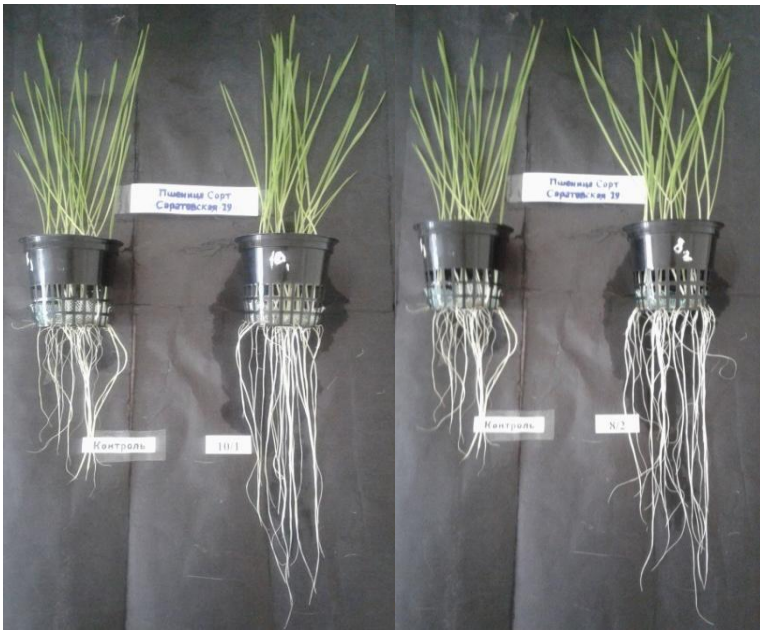


Figure 4. Intensive Growth of Plants and Root System After Treatment on the Left with Potassium Humanosphere, on the Right – in Combination with a Protectant

When counting on a nutrient medium after the intensity of growth of fungal and bacterial microbial flora after seed treatment separately by biofertilizers and in combination with a protectant, it was noted that in the variants of experiments when combined with a protectant there are none or fewer weak sprouts in comparison with the variants where biofertilizers are separate.

**4 Conclusion**

Thus, the treatment of soybean and wheat seeds with biofertilizers, sodium humophosphate, and potassium humophosphate in combination with a protectant significantly improve their sowing qualities, suppress mushroom and bacterial infections and promote the more intensive growth of plants and the root system.

Climatic conditions and water regime, which, in turn, depends on the physical properties of the soil, significantly affect the efficiency of biofertilizer application. With a lack of moisture, the effectiveness of fertilizers is reduced. In areas of insufficient moisture, it is important to foresee the depth of fertilizer application and it is not always advisable to feed agricultural plants. In conditions of sufficient moisture or during irrigation, biofertilizers should be added in larger quantities and effective methods of application should be selected to prevent nutrient leaching into the lower layers of the soil.

When developing a biofertilizer system, it must be borne in mind that the effect of fertilizers largely depends on the level of agrotechnics. Relatively small rates of fertilizers with high agricultural technology can have a significant effect, and increased rates with low agricultural technology often do not give a predictable result. High agrotechnics is a required condition for the effective use of biofertilizers and, conversely, the lack of nutrients limits the use of the created conditions.

Studies on the effectiveness of bio-fertilizers showed a positive effect on the growth and development of soybeans and wheat, contributing to a significant increase in the yield of these crops. Consequently, it can be expected that, based on the results of long-term studies, in the future bio-fertilizers will become an alternative to mineral sources.

On the basis of the data of the studies of each batch of seeds, the specialists of the Institute select the most highly effective drugs against the disease excitants, as well as the norms and specific features of the drug administration.

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**Primary Paper Section:** G

**Secondary Paper Section:** GC, GD, GE