

# INFLUENCE OF FERTILIZERS AND BIOLOGICAL PREPARATION BIOGRAN ON THE VERTICAL MIGRATION OF BIOGENIC ELEMENTS' COMPOUNDS IN POTATO PLANTS

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*The paper presents the results of lysimetric experiments on potatoes grown on sod-podzolic soils. The positive influence of the microbial preparation Biogran on the restriction of biogenic elements and water-soluble humus removal through the soil profile was observed. The effect of preparation is primarily explained due to the increase of the nutrients removal with the yield.*

*Key words: potatoes, inoculation, Biogran, lysimeters, fertilizers, water soluble humus.*

Special features of transformation of biogenic elements' compounds in agrocenoses are known to depend on several factors. They include climatic conditions of the region and season, geochemical influence of soil, vegetation type, anthropogenic effects and microbiological activity. Among the above factors the latter plays a decisive role in the formation and maintenance of soil fertility and productivity of a complex system soil – microorganisms – plant, and this part is the least studied.

Recently, more and more attention is paid in agriculture to unconventional measures of intensifying of production process of crops. Among them special place is occupied by microbial agents that are created based on selected strains of microorganisms of specific functional direction. Their use in agricultural production in some cases promotes explosive growth and development of plants and provides significant increase in productivity of crops and improving the quality parameters of received products [1]. First of all, it is explained by low soil biogenicity of modern agrocenoses due to systematic violations in the application of fertilizers and pesticides, resulting in the inhibition of growth and activity of the representatives of some ecological and trophic groups of microorganisms incl. those forming symbioses and specific associations with plants. Rhizosphere microorganisms are known to be a kind of trophic mediators between soil and plants, so their removal from natural evolutionary generated processes of transformation of biogenic elements significantly affects both the coefficients of absorption of an active ingredient from

fertilizers and crop yields. So, against the low soil biogenicity artificial provision of crops with necessary microbiota ensures the recovery of normocenosis and provides the optimization of their production process. With the intensive development of microorganisms introduced in agrocenosis the production of physiologically active substances is also observed that affect plants rhizogenesis. Increasing of root system of bacterized crops positively affect the absorption capacity of roots that also promotes the increasing of biogenic elements absorption levels [2]. However, the interaction of microorganisms with the plant depends on agricultural background that is to be considered when developing biologized technologies for growing crops. Physiologically appropriate doses of fertilizers are primarily used by plants, which helps limit the loss of biogenic elements also being the result of their removal outside the root soil layer [3].

The goal of our work was to study the intensity of vertical migration of biogenic elements beyond the root soil layer when a microbial preparation is applied to potato cultivation technologies.

**Materials and methods.** The study was conducted in the conditions of a lysimeter installation of Institute of Agricultural Microbiology and Agroindustrial Manufacture of NAAS. The installation contains 48 sections-lysimeters placed in two parallel rows of 24 lysimeters each. Below them vessels-receivers are installed to collect infiltration. By the design the lysimeters are made of concrete, loose type. Lysimeter cells are filled with soil sequentially, starting with the undersolum considering the power of

genetic horizon. The planted acreage of a lysimeter cell is 3.8 m<sup>2</sup>, repetition – quadruplicated. One cell soil layer – 155cm, its weight – 10.5 tons.

Soil for a lysimetric experiment is sod-podzolic sabulous with the following agrochemical characteristics of S horizon (0-23 cm): humus content by Tiurin– 1.1%; salt extraction pH – 5.0; hydrolytic acidity (by Kappen) – 2.5 mg-eq. per 100 g; P<sub>2</sub>O<sub>5</sub> content (by Kirsanov) – 170.0 mg; K<sub>2</sub>O (by Maslova) – 62.0 mg per 1 kg of soil.

Experiment with Bellarosa potato was conducted in 2014. Experiment scheme included the following options:

#### I. Without biological preparation:

- 1 - no fertilizers, control;
- 2 - 40 t/ha of cattle manure litter;
- 3 - N<sub>40</sub>P<sub>40</sub>K<sub>40</sub>;
- 4 - N<sub>80</sub>P<sub>80</sub>K<sub>80</sub>;
- 5 - N<sub>120</sub>P<sub>120</sub>K<sub>120</sub>;
- 6 - 40 t/ha of manure + N<sub>80</sub>P<sub>80</sub>K<sub>80</sub>;
- 7 - green manure (intermediate green manure – blue lupine);

#### II. Application of Biogran:

8-14 – the same agricultural backgrounds.

Microbial preparation Biogran (TU U 24.1-00497360-006:2009) was used in the experiment.

Nitrate content was determined by phenoldisulfonic method, ammonium nitrogen – with Nesler reagent, water-soluble P<sub>2</sub>O<sub>5</sub> – by Kirsanov, K<sub>2</sub>O - flame-photometric method, CaO and MgO – complexometric

method, water-soluble humus - by Turin [4].

Collection and recording of yield was performed by direct method. Statistical analysis of the results was performed by Dospiekhov [5].

**Results and discussion.** The analysis of the content of biogenic elements in washing percolate shows significant loss of nitrogen in the form of nitrates at the application of manure and organic-mineral fertilization – 64.8 and 72.0 kg/ha, respectively (Table 1). Under these conditions intense migration of calcium and magnesium compounds in the vertical soil profile beyond the root layer is observed. Relatively little increase in P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O losses was noted. Removal of soluble humus is increasing at that. Application of Biogran at mentioned

agricultural backgrounds provides significant restriction of nutrients removal.

When applying mineral fertilizers the intensity of removal of soluble humus, nitrates, phosphorus, potassium, calcium and magnesium compounds increases with increasing the doses of fertilizers. The use of biological preparation at these agricultural backgrounds significantly limits the loss of nutrients. In particular, at N<sub>40</sub>P<sub>40</sub>K<sub>40</sub> background Biogran provides reducing the removal of soluble humus substances even compared to control indicators (variant without fertilizers). The same dependence is noted at the other compounds. Combined use of biological preparation and N<sub>80</sub>P<sub>80</sub>K<sub>80</sub> also protects soil from the loss of almost all nutrients studied (compared to control). And only at the background of the largest dose of fertilizer Biogran fails to provide keeping to the indicators close to the control. However, even in this case, we note a significant positive effect of the preparation compared to the values obtained in the variant with N<sub>120</sub>R<sub>120</sub>K<sub>120</sub> use.

The application of green manure provides reducing losses of biogenic elements compounds and water-soluble humus compared to control. Biogran increases the specified effect.

Obviously, green manure accumulates nutrients – first at using them for their own constructive needs, and after embedding in soil gradual mineralization of green manure mass during potato vegetation provides metabolic processes of this crop. This is confirmed by the results of accounting of potato yield (Table 2). Thus, the productivity of the crop grows by 23.8% by the use of lupine green manures, and the combination of this agricultural method with Biogran application provides getting the yield greater than absolute control indicators by 38.1%. Application of manure significantly increases the yield of potatoes. Biogran does not affect the yield of the crop at this agricultural background. We noted this feature earlier, conducting the study in the conditions of field experiments. The effect of levelling the positive effect from manure bacterization, in our view, is explained by the fact that manure bring a huge number of microorganisms to the soil, i.e. a kind of bacterization occurs,

**Table 1. Loss of moisture, water-soluble humus and biogenic elements compounds at growing potatoes under the influence of fertilizers and Biogran**

Experiment variants	Moisture, mm	Losses, kg/ha					
		Water-soluble humus	NO <sub>3</sub>	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	CaO	MgO
Without fertilizers	86	14.0	30.0	2.5	5.0	64.0	16.0
Without fertilizers + Biogran	71	8.0	22.0	2.5	4.0	52.0	12.1
Manure, 40 t/ha	114	16.2	64.8	2.7	6.1	93.6	18.0
Manure, 40 t/ha + Biogran	102	11.3	22.5	2.7	3.6	64.8	11.3
N <sub>40</sub> P <sub>40</sub> K <sub>40</sub>	86	16.8	42.0	3.0	8.0	81.0	18.0
N <sub>40</sub> P <sub>40</sub> K <sub>40</sub> + Biogran	80	12.0	30.0	3.0	4.0	70.0	14.0
N <sub>80</sub> P <sub>80</sub> K <sub>80</sub>	82	20.4	60.0	3.4	8.0	93.0	20.0
N <sub>80</sub> P <sub>80</sub> K <sub>80</sub> + Biogran	80	14.0	30.0	3.0	4.4	72.0	14.0
N <sub>120</sub> R <sub>120</sub> K <sub>120</sub>	80	28.0	91.0	4.2	10.4	105.0	20.0
N <sub>120</sub> R <sub>120</sub> K <sub>120</sub> + Biogran	64	18.2	56.0	3.0	6.8	102.0	19.0
Manure, 40 t/ha + N <sub>80</sub> P <sub>80</sub> K <sub>80</sub>	92	18.0	72.0	3.0	6.8	104.0	20.0
Manure, 40 t/ha + N <sub>80</sub> P <sub>80</sub> K <sub>80</sub> + Biogran	81	12.6	25.0	3.0	4.0	72.0	12.6
Green manure	66	12	20.0	3.0	2.0	55.0	16.0
Green manure + Biogran	60	11.0	19.5	3.0	2.0	52.0	10.0
HIP <sub>05</sub> by experiment	6	4.2	7.0	0.7	0.8	10.1	3.5
for agricultural backgrounds	4	2.2	3.5	0.3	0.4	5.2	1.8
for Biogran and interaction	3	2.0	3.5	0.4	0.4	5.0	1.8

**Table 2. The yield of potato under the influence of fertilizers and inoculation**

Experiment variants	Yield, t/ha		Growth from inoculation		Marketability, %	
	I	II	, t/ha	%	I	II
Control	12.6	15.5	2.9	23.0	75.4	89.0
Manure, 40 t/ha	28.7	28.9	0.2	0.7	87.6	90.1
N <sub>40</sub> P <sub>40</sub> K <sub>40</sub>	19.6	23.2	3.6	18.4	83.9	83.3
N <sub>80</sub> P <sub>80</sub> K <sub>80</sub>	26.1	33.8	7.7	29.5	93.7	96.1
N <sub>120</sub> R <sub>120</sub> K <sub>120</sub>	32.3	34.0	1.7	5.3	94.4	95.1
Manure + N <sub>80</sub> P <sub>80</sub> K <sub>80</sub>	92	41.1	4.1	11.1	97.1	98.5
Green manure	15.6	17.4	1.8	11.5	76.3	83.3
HIP <sub>05</sub> by experiment	1.2					
for agricultural backgrounds	0.7					
for Biogran and interaction	0.6					

Note: I - without seed inoculation, II - seed inoculation with Biogran biological preparation.

creating competitive environment for microorganisms introduced into agrocenosis.

The use of Biogran at the backgrounds of mineral fertilizers provides the greatest yield growth rates in the experiment. The optimized in this regard is the combination of N<sub>80</sub>P<sub>80</sub>K<sub>80</sub> with microbial preparation. Yield in these conditions increases by 29.5%. High yield growth from bacterization is noted at the

background N<sub>40</sub>P<sub>40</sub>K<sub>40</sub>, and at the use of organic and mineral fertilization.

The growth of potato yield from the use of Biogran largely explains the effect of reducing nutrients removal by the soil profile. Under these conditions biogenic elements compounds are directed for their intended purpose – for plants constructive needs. At this, according to our previous studies,

removal of nutrients with harvest increases. An additional explanation could also be and accumulation of nutrients in the enlarged root system of plants, as shown earlier [2]. At this, of course, biogenic elements kept by root system will get to the following crops in rotation.

Thus, the use of complex action biological preparation Biogran in potato production technology enhances the increase in crop productivity and decrease in biogenic elements loss, particularly water-soluble humus and nitrogen in the form of  $\text{NO}_3$  as key indicators of fertility and ecological condition of soils.