POLYFUNCTIONALITY OF THE INFLUENCE OF A COMPLEX NANOCOMPOSITE BACTERIAL PREPARATION AZOGRAN ON PLANT PRODUCTIVITY

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The complex nanocomposite bacterial preparation Azogran was created on the basis of the interaction of highly active nitrogen-fixing bacteria *Azotobacter vinelandii* IMV B-7076 and phosphate-mobilizing bacteria *Bacillus subtilis* IMV B-7023 with nanoparticles of the clay mineral bentonite. In the process of such interaction, bacterial cells are covered with bentonite particles, in doing so increases their viability during storage and adhesion to the surface of plant seeds during their bacterization before sowing into the soil. Such treatment of seeds increases their germination and the formation of seedlings.

Table 1. The number of viable cells of *Azotobacter vinelandii* IMV B-7076 (cells per mL) at store in physiological solution (control) and in 10% bentonite nanocomposite (layer thickness 50 mm).



**Fig.1. Interaction of bacteria** *Azotobacter vinelandii* **IMV B-7076 with bentonite nanoparticles** 

Storage duration, month	The number of viable cells (cells per mL)	
	control	nanocomposite
0	$(7,6\pm0,5)\cdot10^{8}$	7,4 <u>+</u> 0,6 10
1	$(1,1\pm0,4)\cdot10^{8}$	6,5 <u>+</u> 0,5
3	(5,9±0,5)·10 <sup>6</sup>	5,2 <u>+</u> 0,7
6	$(8,4\pm0,8)\cdot10^{5}$	<b>2,8±0,5</b>



At treatment of plants by this preparation the content of phenolic compounds increased in their organism. These biological active substances can reduce the levels of reactive oxygen species in plant tissues, which accumulate at negative environmental factors. Furthermore, inoculation of seeds by Azogran significantly increased the antioxidant enzymes (peroxidase, superoxide dismutase and catalase) activities, content of chlorophylls and carotenoids pigments in different plant species (barley, marigold, beans).

Table 2. The effect of the complex bacterial preparationAzogran on catalase activity in potato leaves after its infectionwith the X-virus

Variants the treatment of plants	Catalase activity, µmol/min · mg of protein
Control (untreated plants)	115,5 ± 3,9

Fig. 2 The number of viable cells (N) of *Azotobacter vinelandii* IMV B-7076 depending on the concentration (C) of manganese cations in the medium without nanomaterials (1) and with bentonite (2) or saponite particles (3).

The interaction of these bacterial strains with the bentonite nanocomposite significantly affects their physiological and biochemical activity. Thus, during cultivation of these bacteria in nutrient medium that contained 0.05–0.5 g/L of bentonite nanoparticles, the growth and ATPase activity of these strains increased significantly.



The plants are infected with the X-virus	95,6 ± 2,5
Azogran	$159,3 \pm 7,3$
The plants are infected with the X-virus + Azogran	202,7 ± 4,6

Table 3. The level of malondialdehyde in leaves of barley Viraj variety (phase of emergence into the tube) after seed treatment with the stress-agent - hydrogen peroxide and post-treatment with nanocomposite mono- or complex bacterial preparations

Variants the treatment of seeds	Concentration of malondialdehyde, µM/g raw mass
Control (untreated plants)	$26.58 \pm 3.74$
<b>33% H<sub>2</sub>O<sub>2</sub></b>	$46.82 \pm 7.51$

We are being shown that the use of the Azogran increases the resistance of plants to phytopathogenic microorganisms and viruses, as well as to phages.

The use of this preparation significantly reduces the infection of potato by phytoviruses. The Azogran significantly reduces the spread of the Colorado potato beetle in the potato phytocenosis and leads to the death of more than 65% of the larvae of this phytophage.

<b>33%</b> H <sub>2</sub> O <sub>2</sub> + <i>A. vinelandii</i> IMV	$29.06 \pm 3.54$
<b>B-7076 + nano-bentonite</b>	
33% H <sub>2</sub> O <sub>2</sub> + <i>B. subtilis</i> IMV B-	$25.51 \pm 5.77$
7023 + nano-bentonite	
33% H <sub>2</sub> O <sub>2</sub> + Azogran	$28.03 \pm 2.66$

The use of the complex bacterial preparation Azogran in crop production has a significant effect on the growth and development of plants, improving their nitrogen and phosphorus nutrition, stimulating their growth with biologically active metabolites, including phytohormones. The use of the complex bacterial preparation Azogran in crop production significantly increases plant productivity (on 18-37%).