

Krawczyńska Małgorzata

Kolwzan Barbara

Rybak Justyna

Molska Justyna

Wrocław University of Technology, Biology and Ecology Group,

Plac Grunwaldzki 9, 50-377 Wrocław, Poland

Krzysztof Gediga

Wrocław University of Environmental and Life Sciences, Department of Plant Nutrition,

Grunwaldzka 53, 50-357 Wrocław, Poland

Karpenko Elena

Lviv Department of Physical Chemistry InPOCC National Academy of Sciences of Ukraine,

Naukova str. 3a, 79060 Lviv, Ukraine

Effect of biopreparations on plant growth stimulation on the post-flotation tailings

The influence of the pre-sowing treatment of seeds with biopreparations based on biosurfactants and nitrogen-fixing bacterium on the growth, as well as accumulation of nutrients and heavy metals in plant tissues of five species of plants when growing on post-flotation tailings was studied. The stimulating influence of applied biogenic agents was established.

Исследовано влияние предпосевной обработки семян биопрепаратами на основе биоПАВ и азотфиксирующих бактерий на рост, а также накопление питательных веществ и тяжелых металлов в тканях растений пяти видов при выращивании на постфлотационных отвалах. Установлено стимулирующее влияние использованных биологических препаратов.

Post-flotation tailings belong to the post-industrial wastelands which are very difficult to deal with when it comes to their reclamation. A phytostabilization is a universally used treatment relying on introducing the flora into the contaminated zone. The areas of post-flotation tailings are not suitable for biological life development. The reason is the physicochemical properties of deposited sediments. Granulometric composition of the deposit is mainly dusty-argillaceous with the small addition of sandy fractions. Alkaline pH (H₂O) of stored waste (pH = 8, 1) is connected with the high content of CaO and causes a hindrance of the transition of heavy metals contained in the waste to the aqueous solution. At the same time the alkalinity of the waste constitutes the limiting factor, even entirely blocking the availability of nitrogen and phosphorus for microorganisms and plants. Additionally, the extremely bad air and water conditions, the limited number of assimilable elements for plants (C, N, P), the relatively large content of heavy metals (copper and lead), the lack of organic substances altogether contribute to adverse conditions for the development of microorganisms and plants growth [1,4].

Nowadays, attention is devoted to the analysis of the influence of improving seeds on the stimulation of biogens uptake as well as their power and energy of the germination [2]. Treatments of this type consist in covering the surface of seeds with substances protecting against microorganisms or increasing the availability of biogenic substances. The main aim of the pre-sowing treatment of seeds is to increase the resistance of plants for illnesses of viral, bacterial or fungal origin and to supply them with the initial dose of fertilizers for the germination and first stage of plant growth.

The application of biopreparations on the basis of the substances of the biological origin is one of the methods of the treatment of seeds before planting. Biosurfactants are one of the perspective agents used for this purpose. Their application allows not only the protection of seeds against microorganisms, but also the simultaneous facilitation of the uptake of biogenic substances by plants e.g. phosphorus [5].

It is known that the addition of biosurfactants can have a beneficial effect on the capacity of seeds germination. Moreover, they can be applied along with chemical plant protection products contributing to the increase of their solubility and level of granularity [3].

The research on the possibility of biopreparations application for the reclamation of post-flotation tailings was the aim of presented work. The samples used in the experiment were obtained from the closed tailings dump "Wartowice No. 3". The dump is located in the area of Old Copper Mining Region in the Warta Bolesławiecka area which was left without any reclamation.

A biosurfactant as well as nitrogen-fixing bacteria *Azotobacter sp.* were applied for the treatment of seeds in the experiment. Biosurfactant – rhamnolipid biocomplex from *Pseudomonas sp.* PS-17 and bacterium *Azotobacter sp.* were provided by Lviv Department of Physico-Chemistry of Combustible Minerals InPOCC, National Academy of Sciences of Ukraine. Five species of plants were used in our studies: *Zea mays*, *Avena sativa*, *Sinapsis alba*, *Pisum sativum*, *Lupinus albus*. Conducted research showed the usefulness of biopreparations prepared on the basis of biosurfactants and nitrogen-fixing bacteria for the pre-sowing treatment of seeds. An influence of biopreparations on accumulation of biogenic substances and heavy metals in plant tissues has also been assessed.

A beneficial effect of the treatment of seeds with biopreparations on assimilation of biogenic elements by plants was observed. The obtained results were dependent on the type of biopreparation used. Fig.1 presents the achieved results.

Seed stimulation was conducted in two variants:

- Variant 1 (PS) – seeds of plants were stimulated through one hour with biopreparation containing the biosurfactant (concentration 0,05 g/L).
- Variant 2 (AB) - only three species were planted: *Zea mays*, *Sinapsis alba*, *Avena sativa*. The seeds were placed in nutrient medium containing nitrogen-fixing bacteria *Azotobacter sp.*

Table 1. The average concentration of biogenic substances and heavy metals in plants.

<i>Zea mays</i>				
Macroelements	K	Ca	Mg	P
	[mg/kg]			
variant 1	34438	6050	4163	500
control 1	33875	5888	4088	575
variant 2	32063	5638	3188	850
control 2	34313	5631	3531	775
Microelements	Mn	Cu	Fe	Zn
	[mg/kg]			
variant 1	11,4	37,8	63,8	17,9
control 1	10,2	36,3	61,0	16,0
variant 2	11,7	39,5	52,3	16,4
control 2	13,3	41,5	55,8	18,2

<i>Avena sativa</i>				
Macroelements	K	Ca	Mg	P
	[mg/kg]			
variant 1	53125	5725	2475	575
control 1	51000	5638	2594	550
variant 2	45063	4200	1919	650
control 2	44688	4425	1925	475
Microelements	Mn	Cu	Fe	Zn
	[mg/kg]			

	[mg/kg]			
variant 1	13,6	91,3	73,5	40,3
control 1	10,7	93,5	68,8	37,3
variant 2	7,9	54,8	44,0	21,3
control 2	6,5	58,3	37,0	19,0

<i>Sinapsis alba</i>				
Macroelements	K	Ca	Mg	P
	[mg/kg]			
variant 1	32500	14350	8063	700
control 1	33375	15200	8550	750
variant 2	23875	11200	4888	1200
control 2	25500	12375	6213	900
Microelements	Mn	Cu	Fe	Zn
	[mg/kg]			
variant 1	15,2	34,5	30,0	46,0
control 1	13,6	43,0	96,5	71,0
variant 2	12,3	16,0	34,5	25,5
control 2	13,0	29,5	52,0	39,5

<i>Lupinus luteus</i>				
Macroelements	K	Ca	Mg	P
	[mg/kg]			
variant 1	42468	23503	11467	3729
control 1	47491	18821	12264	4284
Microelements	Mn	Cu	Fe	Zn
	[mg/kg]			
variant 1	35,1	118,7	98,8	61,4
control 1	38,3	117,4	134,6	67,9

<i>Pisum sativum</i>				
Macroelements	K	Ca	Mg	P
	[mg/kg]			
variant 1	31276	26343	5714	795
control 1	27008	30740	5983	708
Mickroelements	Mn	Cu	Fe	Zn
	[mg/kg]			
variant 1	12,2	125,2	89,1	27,2
control 1	13,3	143,9	126,0	39,8

Acknowledgment

The research was carried out as the statutory activity number S30 035 at Wroclaw University of Technology.

Literature

1. Karczewska A. Król A. Zawartość i formy rozpuszczalne Cu, Zn, Pb w glebach rejonu składowiska odpadów flotacyjnych Wartowice w rejonie Bolesławca. *Ochr. Środ. i Zasob. Natur.* 31,313,2007.
2. Lang S., E. Katsiwela, F. Wagner, Antimicrobial effects of biosurfactants. *Fat Sci. Technol.* 91 Janrgang, #9, 1989, p. 363-366
3. Mata-Sandoval J.C., Karns J., Torrents A. Effect of rhamnolipids produced by *Pseudomonas aeruginosa* UG2 on the solubilization of pesticides. *Environ.Sci Technol.*2000,34, 4923-4930
4. Mizera A., Badanie wartości glebotwórczej odpadów zdeponowanych na składowisku 1,2,3 w aspekcie ich przydatności na zabiegi rekultywacyjne. Centrum Badawczo Projektowe Miedzi Cuprum. Wrocław. 2003
5. Mukherjee S., Das P., and Sen R., Towards commercial production of microbial surfactants. *Trends in Biotechnology* 24 (2007) 11 99-121
6. Mulligan C.N., Environmental applications for biosurfactants, *Environ. Pollut.*, 2005, 133, 183-198.