The effectiveness of using bioremediation measures to podzolized chernozem, which is contaminated by heavy metals

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INTRODUCTION

Biological degradation of soils, which were polluted by anthropogenic factors, is defined as a process of steady changes of soil biological characteristics, and manifests in quantity adjustment of microorganisms, decreasing of various species and disfunction of balance among various species of soil's meso- and microfauna, the increasing of pathogenic microflora and changing the intensity of biochemical processes.

Support and activization of soil microbicenosis may be implemented by its artificial enrichment with high-value selected Bacillus bacterial cultures. Its various biological activity, high resistibility to adverse environmental conditions have a high profile in circulation of elements in nature, forming stability and activity in soil biological processes. Consequently, there is an opportunity to develop bioremediation method of anthropogenic load reduction on soil and support of its biological activity using *Bacillus* bacterial cultures, which have a complex of useful agronomic capabilities.

METHODOLOGY

Microbiological and biochemical researches were performed with samples, which were selected from rhisosphere of spring barley, which was growing in polluted with heavy metals podzolized chernozem on the level of 5 clarks Cd (5 mg/kg), Pb (10 mg/kg), Ni (250 mg/kg), Zn (250 mg/kg) on condition of introduction of active strains of microorganisms.

We determined the following soil indices :

- number of microorganisms belonging to basic ecotrophic, taxonomical and physiological groups;
- activity of soil enzymes (dehydrogenases, invertases, polyphenol oxidase);
- the integrated indexes of biogenesity (IIB), biological activity (IIBA), and biological condition (IIBC)

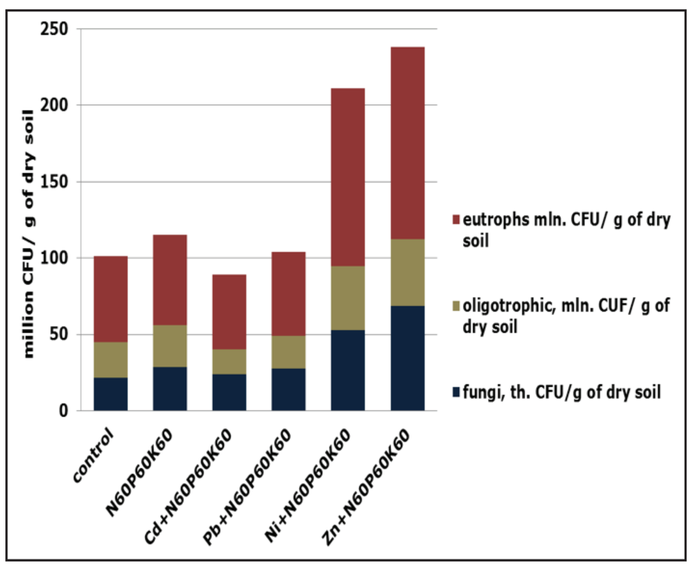

Fig. 1: Structural changes of microbial cenosis in spring barley rhisosphere, which was grown in podzolized chernozem, under the influence of heavy metals

RESULTS AND DISCUSSION

The main opression happens under the influence of Cd and Pl, where microbal cenosis decreasing a population of eutrophic groups on 7-18% respectively, which are capable to adopt an ogranic nitrogen, on 23-40% - the population of oligotrophic microorganisms, on 5-16% - micromycetes comparatively with the control (without pollution) (Fig. 1).

In such a manner, biogenesity was increased on 52-97% according to the main ecotrophic groups of microorganisms concerning variants, where there was Ni integrated, while Zn variants - biogenesity was increased almost in 1,6-4,5 times comparatively with control. Here there is a key distinction comparing with repressive Cd and Zn activity, which substantively depress a growth and development of soil microorganisms. At the same time, the artificial soil enrichment with active bacilli cultures profoundly change the orientation of the rebuilding processes of microbial cenosis in contaminated soil (Fig. 2).

The quantity of eutrophs was increased min on 4%, max – on 145% in control variants (agricultural background $N_{60}P_{60}K_{60}$ without contamination). But on condition of artificial enrichment with highly-active pure bacilli culture, microbial cenosis resumes its useful agronomic properties, in some variants even to the level of uncontaminated soil, where the calculated integrated index of soil biogenesity (IIB) indicates on it (fig. 2).

Entering of active bacilli strains appreciably improved dehydrogenase activity in the majority of variants: background with Cd it is detected the increasing on 17 %, background with Ni – already on 40 %, especially against the background with Pb – in 2,7-2,9 times comparatively with soil indexes without introduction.

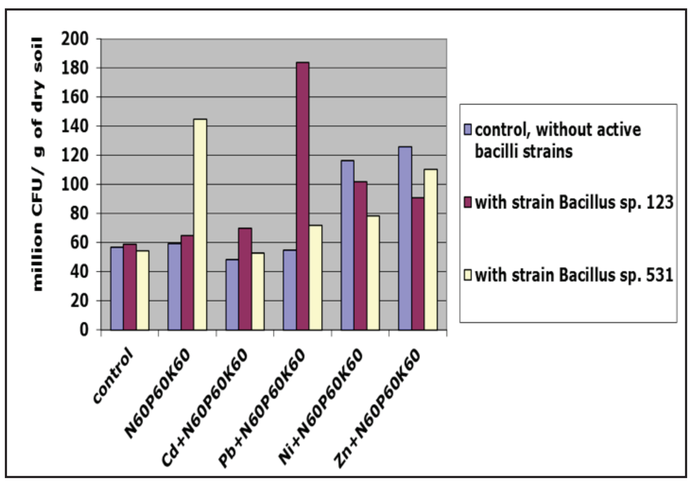

Fig. 2: The influence of active bacilli strains introduction on biogenesity of podzolized chernozem, which is contaminated with heavy metals

The calculated integrated index of biological activity (IIBA) of podzolized chernozem point out on yet more sensibility of fermentative soil activity till negative influence of heavy metals comparatively with quality and quantity indicators of microbial community structure.

The character of changes microbial communities depends on definite property package, which is related to introducted bacteria. The biggest resistibility to heavy metals was found out by bacilli strain *Bacillus* sp. 531 with nitrogen-fixing and growth parameters; a little lower effectivenes was found out by the strain *Bacillus* sp. 123 with antagonistic and growth parameters (fig. 3).

CONCLUSIONS

- On the basis of the complex of biological parameters it is proved, that heavy metals (Cd, Pb, Ni, Zn) on the level of 5 clarks have a negative influence on biological properties of podzolized chernozem. The most toxic in soil are Cd and Pl.
- Using the introduction of bacilli strains with complex of agronomically useful proreties activate microbial communities in rhisosphere of spring barley, which was grown in podzolized chernozem and was contaminated with heavy metals, that is point out to fixity of Bacillus bacteria for toxic effect of Cd, Pb, Ni, Zn.
- In order to use in practice this microbiologic agro-method for its effectiveness it is necessary to take into account the specificity of negative influence on soil microbiota of every metal and physiological peculiarity of integrated bacterial cultures. The highest resistibility to heavy metals was defined by bacilli strain *Bacillus* sp. 531 with nitrogen-fixing and growth parameters.

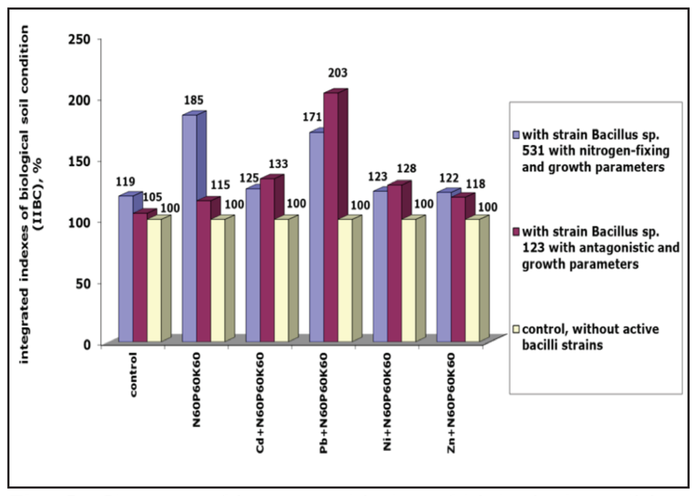

Fig. 3: Changes of integrated index of biological condition (IIBC) of podzolized chernozem, which is contaminated with heavy metals, under the influence of selected microorganisms introduction

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