PROSPECT USING OF PHYTOREMEDIATION OF POLLUTED WITH HEAVY METALS AND RADIOACTIVE ISOTOPES AGRICULTURAL LANDS IN BELARUS.

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Abstract

The most contents of pollution is in the soil to in cities and industry centers. This is caused on the one hand by characteristic of soil to accumulate pollute materials with other - arrival on surface of soil of greater amounts of different chemical materials with atmospheric precipitation (draft), aerosol fallout's and etc. Accumulated for a long period in soil polluting materials are the sources of secondary soiling an atmospheric air of shallow and underground water. Degree of danger of earning one's living surges to take to value on the scale stress- factors. In 1975 top line is occupied pesticides, at present on the first place is occupied heavy metals.

Maximum contents of lead is fixed in soil of Brest`s region. Excess on the background has formed 18.3 once. Maximum excess on the background on the zinc is installed in Grodno`s region an excess has formed 22.0 times. . The most contents of the copper in the soil are installed in Mogilev`s region and in the Orsha-accordingly 32.0 and 21.5 times above background. On the nickel most excesses on the background are installed in soil of Brest`s region. Besides soil of Republic Belarus are polluted by radioactive isotopes a caesium 137 and strontium- 90.

The question nowadays is how to clean and restore the arable lands, preserving their main function. In other words, the technologies, available and widely used for soil remediation from heavy metals contamination do not justify the label “remediation” because of their highly destructive character - the soil, which is regarded as a non-renewable resource is thoroughly wasted. A possible alternative solution of the situation could be the new emerged technology of phytoremediation.

As a newly emerged transdisciplinarity field of science, phytoremediation offers more questions than answers:

- it is time consuming process, which makes usefulness for soil, contaminated middle and high concentrations of heavy metals.
- this process which is very strongly dependent of the kind of soil (for example by changing the pH) and climate.
- this process is strongly dependent of the kinds of metals, which could form complexes are readity subjected to phytoremediation. Some increase of the bioavailable part of the metal content could be achieved by application of special chelation agents and high concentration ions of hydrogen in the solution (pH)

Phytoremediation is still in infancy and its operating characteristics have not been fully demonstrated. The research activities are many laboratory experiments on hydroponic solutions or soil pot tests with relatively few field application studies on small areas. The data available from different sources is sometimes rather inconsistent and contradictory. However the gathered so far material provides not bad basis for the formulation of principles with practical value for future experiments

The technical methods must include traditional chemical methods and physical such as atomic absorption spectroscopy, a new ecological application of laser mass spectroscopy.

Introduction The soil complex in the Belarus after Chernobyl`s accident has accumulation long lived radio nuclides. The polluted soil today to functions as the basic source delivering radionuclides in various components biosphere. Radioactive contamination of soil continues to be one of the most serious environmental problems. The total activity of all radioactive material released in the Chernobyl Nuclear Power Plant. Belarus accident is presently estimated to have been $5.7x10^{18}$ to $14x10^{18}$ Bq). More than 18 thousand km^2 agricultural lands have be polluted from which 2.64 thousand km^2 it was necessary to exclude from economic circulation. (fig.1 and 2) ^{137}Cesium was one of the major products released during the accident. Radiocesium is a byproduct of nuclear fission and is characterized by slow decay (t 1/2 30.2 yr). The presence of radionuclides in soil and water often jeopardizes the ecosystem stability and poses serious danger to human health (1,2). Eight cultivars of different crop plants were evaluated for the ability to accumulate $_{137}$Cs from the ^{137}Cs-contaminated soil after Chernobyl`s accident and heavy-metal contaminated soils are quite a common and widespread phenomenon in industrialized regions. At the selected site, soil was characterized for ^{137}Cs and heavy-metal activity before and after the field experiments. All of the tested cultivars were able to accumulate ^{137} Cs hea vy-metal in above soil parts. A variety of the environmental restoration methods for radioactively contaminated sites have been developed and used with some success (3). However, these technologies may be prohibitively costly if large areas of land or volumes of water are involved. Hence, there is a great need for reliable and inexpensive technologies capable of reducing radiation to environmentally acceptable levels. Such technologies might also be effectively used in pollution prevention and waste reduction programs. Recently, significant attention has been drawn to phytoremediation, an emerging technology using plants to remove pollutants from the environment. Phytoremediation could provide an affordable way to restore the economical value of contaminated land. This technology employs a plantis natural ability to concentrate various elements in their tissues. The ability of plants to tolerate elevated levels of heavy metals, and to accumulate them to unusually high levels has been shown in a number of different plant species (4, 5). However, the value of metal-accumulating plants for environmental remediation has been fully realized only recently (6-9). Several phytoremediation technology are being developed (10). The most advanced are: the use of metal-accumulating plants, which can transport and concentrate metals from the soil in the roots and above ground shoots, the use of plant roots to absorb, concentrate and precipitate heavy metals from aqueous streams, the use of plants to eliminate the bioavailability of heavy metals and radionuclides in soils.

Researches of the migrating forms of radionuclides in the soil of Belarus.

Behaviour an radionuclides, received in soil as a result

Chernobyl`s damages is defined by two main factors:

- particularities of the chemical forms an radionuclides in atmospheric precipitation
- local geochemical features of natural ground and velocities of processes of changing the forms an radionuclides

For determination of dependency migrating characteristics

- For the determination of dependency migrating characteristics of complex join, formed by organic jsubstances (gum and fulvo acids) with radionuclides, from the type of soil was determined amount of the soil forms an radionuclides. These soil forms following:
    - water soluble
    - exchange
    - acid soluble
    - fixed

they were determined in the system soil - water extract- saline extract - acid extract - insoluble remainder. It Here were determined contents of heavy metals Mn, Cd, Pb, Ni, Cu, Co, Zn.

In marsh low peat ground radionuclides migrate slowly and through 12 years after the accident on Chernobyl Power Station main amount ^{137} Cs (89%) and (74%) ^{90} Sr bases in upper 5 cm of layer of soil, decreasing with the depth. .Particularities to migration an radionuclides in the soil are stipulated that, in what chemical forms they inhere.

Determination water soluble, exchange and acid soluble forms of ^{90}Sr and ^{137}Cs by method of the consistent extraction has shown that in the soil of the over humidificating peat bed contents ^{137}Cs in water soluble, exchange forms in 30 and 9 once above, than in dewater peat soil. Contents acid soluble forms in both events equally. In peat ground 35-55% ^{90}Sr bases in strongly bound condition and extracts 6 Ì HCl. 50-70 % ^{90}Sr is in exchange ,form but 3-5 % is in water soluble form. For the determination of the forms of findings an radionuclides were used methods, based on selectiving leach of elements during consistent processing of the soil by solutions different composition. In water extract go the form an radionuclides, whic/h were the most capability to migration, which can move with motion soil water. Exchange forms an radionuclides, stand out ammonium by means of 1 M acetate. These forms are formed as a result absorptions them on the mechanism of ion exchange. In extract, extracted by 1 N HCl (acid soluble forms) go hard exchanging ions of
radionuclides , small-soluble ions, forms,_sorption_by oxides a ferric and aluminum. Dynamic balance is supported between these forms. In the soil* stay firmly bolted forms an radio nuclides, enclosed in crystalline lattice of minerals. Maximum contents of the forms an radionuclides in % from the gross amount an radionuclides in the upper of layer of soil, shown in Table 1.

Table 1 Maximum contents of the forms an radionuclides in % from the gross amount an radionuclides in the upper of layer of the soil.

The radionuclide	The form	The type of soil	
		piece of turf-podzol	peat bed
Pu $^{229, 240}$	water soluble	0.77-4.3	0.36-0.8
	exchange	4.1-14	0.7
	acid soluble	4.5-9.8	0.65-1.1
Am ^{241}	water soluble	0.3-0.5	0.2-0.48
	exchange	8.0-30	1.5-2.5
	acid soluble	50-70	20-45
Cs ^{137}	water soluble	0.16-1.2	0.04-5.0
	exchange	0.31-6.5	0.6-1.0
	acid soluble	0.15-12	1.4-2.0
Sr ^{90}	water soluble	3.2-17	0.2-6.2
	exchange	43-80	21-24
	acid soluble	14-25	69-72

Contents of the rolling forms an radio nuclides in piece of turf-podzol_soil in 2 and more once above, than in peat bed that indicative of important organic forming of the soil in the fixing of radionuclides.

Phytoremediation of polluted lands by local plants of Belarus.

The standard procedures a peelings and disinfection of the soil include of itself complex of physical and chemical moreover highly high-priced methods, in accordance with excavations and transportation of the polluted soil for further processing the soil amounts of the soil.

A possible alternative solution of the situation could be the newly emerged technology of phytoremediation. The idea of using plants in environmental remediation is based on the specific capabilities of selected terrestrial plants -hyperaccumulators to extract with their root system toxic elements from the soil and the groundwater and translocate them to the shoot tissues in accumulator depots. The shoot - leaves and stallc biomass is further harvested and processed.

The process of phytoremediation depends greatly on the metal availability in the soil. Only free metal ions and partially the soluble metal complexes are readily subjected to phytoremediation. Some increase of the bioavailable part of the metal content could be achieved by changing the pH level, by the application of special chelation agents and changing the fertilizers to exploit the metal competition in a solution, or by parallel application of engineering remediation techniques, such as electroosmosis.

Most of the reported hyperaccumulators are exotic wild African and Australian plants, with small biomass and undefined growth requirements and characteristics in respect to European climate.

In this paper we are evaluating the applicability of phytoremediation for environmental restoration of soil contaminated with Cs^{137}heavy metals by means of our local plants. In this study, we evaluated eight cultivars of different crop plants for the ability to accumulateCs^{137} from the ^{137} Cs contaminated soil at the as rezult Chernobyl`s accident. (11)

The accumulation of ^{137} Cs in plants is a complex process that is determined by an interaction of numerous factors. Soil type and soil physico-chemical properties, timing from the 137 Cs deposition, type of radionuclide deposition, and plant species physiology are among the major factors affecting radiocesium accumulation in plants. In this study, a combination of soil properties and aging time determined the behavior of ^{137}Cs in the soil and its potential bioavailability. It was shown that ^{137} Cs accumulation by plants was determined by the content of exchangeable and mobile forms of radionuclide in the soil (11).

Researches of local plants- hyperaccumulators of heavy metals and radionuclides has shown that some from them can be indicators of pollution of the soil. Types of plants, which can be as indicators: Tussilago farfafa L., Urtica dioica L., Artemisia vulgaris, Trifolium hybridum L., T. repens L., Phleum pratense L. Separate types of plants can accumulate more than 100 mg/ kg of dry weight for Cd, more than 320 mg/kg of dry weight for Pb, Co, Cu and Ni. Very gratifying results received for the accumulation Zn and Mn - more than 400 mg/ kg of dry weight of plants.

For successful restoration of radioactively contaminated territories, it is crucially important that plants be able to remove a significant portion of radioactivity from the soil. In addition to high biomass production, a potential phytoremediation crop should have the ability to accumulate radionuclide in the above-soil; parts to the concentration exceeding the soil concentration. Separate types, perspective specific drives, such as: Rubus idaeus L., Alisma plantago aquatica accumulate toxic radio nuclides under different radioactive contamination levels. Contents an radio nuclides reached nx10000 Bq/kg.

Spatial sharing an accumulation an radionuclides in plants is defined by the structure and particularities of seizure of pollutants. Plants with more high accumulation ^{90}Sr is characterized high mass of the plant, but types with more high accumulation ^{137}Cs are characterized low mass of the plant, but significant participation in the spatial structure of the ecosystem.

Under more high contents in plants Mn and Cu, responsible for processes of breath, photosynthesis and nitric exchange, plants- accumulation of radionuclides, both in the wood, and in the industry platform, contain these microelements less that furnish a realignment of biochemical mechanism of photosynthesis and nitric exchange.

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