ACCUMULATION OF HEAVY METALS IN PLANTS

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ABSTRACT

The intensification of industrial and agricultural production, the development of transport and the intensification of mining activities inevitably lead to the pollution of natural ecosystems. At the same time, soil is one of the main objects of pollution. As a result of pollution, the quality of soil and agricultural land decreases. One of the most serious aspects of this problem is that compounds that fall into the soil are absorbed by plants and accumulate in them in concentrations dangerous to human and animal health.

Keywords: *Industrial enterprises, agriculture, heavy metals, the process of accumulation of heavy metals, toxicity of metals, sources of distribution of heavy metals, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, molybdenum, cadmium, tin, mercury, lead, bismuth.*

АННОТАЦИЯ

Интенсификация промышленного и сельскохозяйственного производства, развитие транспорта и интенсификация горнодобывающей деятельности неизбежно ведут к загрязнению природных экосистем. В то же время почва является одним из основных объектов загрязнения. В результате загрязнения снижается качество почвы и сельскохозяйственных угодий. Одним из наиболее серьезных аспектов этой проблемы является то, что соединения, попадающие в почву, поглощаются растениями и накапливаются в них в концентрациях, опасных для здоровья человека и животных.

Ключевые слова: *Промышленные предприятия, сельское хозяйство, тяжелые металлы, процесс накопления тяжелых металлов, токсичность металлов, источники распространения тяжелых металлов, ванадий, хром, марганец, железо, кобальт, никель, медь, цинк, молибден, кадмий, олово, ртуть, свинец, висмут.*

Introduction: Today, more than 40 elements of the periodic table of D.I. Mendeleev with an atomic mass of more than 50: vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, molybdenum, cadmium, tin, mercury, lead, bismuth and other several dozen metals are included to the group like heavy metals [1].

In recent years, soil contamination with heavy metals has been observed near cities and large industrial centers.

The phytotoxicity of heavy metals depends on their chemical properties: examples of this are valence, ionic radius and ability to form complexes. In most cases, according to the degree of toxicity, the elements are arranged in the following sequence: Cu > Ni > Cd > Zn > Pb > Hg > Fe > Mo > Mn. However, this range of toxicity of elements may vary slightly depending on the rate of their absorption in the soil layers and plant growth conditions, physiological and genetic characteristics.

A United Nations Environment Program (UNEP) report lists seven metals and three semi-metallic elements as the most dangerous heavy metals: copper, tin, vanadium, chromium, molybdenum, cobalt, nickel and antimony, arsenic and selenium.

According to the danger to human health, heavy metals are divided into the following classes:

Class 1: (most dangerous): cadmium, mercury, selenium, lead, zinc;

Class 2: cobalt, nickel, copper, molybdenum, antimony, chromium;

Class 2: barium, vanadium, tungsten, manganese, strontium [1].

Analysis and methodology of the literature: Heavy metals exist in soils in two phases - solid and soil solution. The form of the presence of metals is determined by the reaction of the environment, the chemical and material composition of the soil solution, and, above all, the composition of organic matter. Elements that pollute the soil - complex substances accumulate mainly in its upper 10-cm layer. Cadmium, copper, nickel, cobalt have a strong migration ability in an acidic environment. A decrease in pH by 1.8-2 units leads to an increase in the mobility of zinc by 3.8-5.4, cadmium by 4-8 and copper by 2-3 times [4].

Thus, heavy metals are involved with organic ligands during podand and povu and form complex compounds. At low concentrations (20-30 mg/kg) in the soil, about 30% of lead is in complex compounds with organic compounds. The percentage of lead complex compounds increases up to its concentration of 400 mg/g and then decreases.

The absorption of chemical elements by plants is an active process. Passive diffusion accounts for only 2-3% of the total mass of assimilated mineral components [2]. Active absorption of ions occurs when the amount of metals in the soil is at the background level.

In acidic soils, an intensive accumulation of heavy metals is observed in comparison with soils with a neutral or close to neutral reaction of the environment. The toxic effect of high concentrations of heavy metals on plants can manifest itself in disruption of the supply and distribution of other chemical elements. The nature of the interaction of heavy metals with other elements varies depending on their concentration. Their transition and migration into plants is carried out in the form of complex compounds [4].

In the initial period, environmental pollution with heavy metals, due to the buffer properties of the soil, leads to the inactivation of toxic substances, plants are almost not negatively affected. However, the protective functions of the soil are not unlimited. As the level of heavy metal contamination increases, their inactivation is not complete and the ion flux affects the roots. Some of the ions can pass into a less active state even before entering the root system of plants. It is, for example, adsorbed on the outer surface of the roots by chelation or complexation by root secretion.

Despite the protective functions of the root system, heavy metals enter the roots under polluted conditions. At the same time, protective mechanisms are activated, as a result of which there is a specific distribution of heavy metals among the organs of plants, which makes it possible to ensure their growth and development as fully as possible. At the same time, for example, in heavily polluted environments, the content of heavy metals in the tissues of roots and seeds can vary by 500-600 times [1].

Results and discussion: A.P. Vinogradov (1952) singled out plants capable of concentrating elements. He pointed out two types of plants - concentrators:

1) plants concentrating elements on a mass scale;

2) plants with selective (species) concentration. Plants of the first type are enriched with chemical elements if the latter are contained in the soil in an increased amount. The concentration in this case is caused by an environmental factor. Plants of the second type are characterized by a constantly high amount of one or another chemical element, regardless of its content in the environment. It is due to a genetically fixed need [2].

Hyperaccumulating plants have been found in the families *Brassicaceae, Euphorbiaceae*, *Asteraceae*, *Lamiaceae*, and *Scrophulariaceae* (Baker 1995). The most famous and studied among them is *Brassica juncea* (Indian mustard) - a plant that develops a large biomass and is capable of accumulating Pb, Cr (VI), Cd, Cu, Ni, Zn, 90Sr, B and Se. Of the various plant species tested, *B. juncea* had the most pronounced ability to transport lead to the aerial parts, while accumulating more than 1.8% of this element in the aerial organs (in terms of dry weight). With the exception of sunflower (*Helianthus annuus*) and tobacco (*Nicotiana tabacum*), other plant species not belonging to the *Brassicaceae* family had a biological absorption coefficient of less than 1 [3].

Soils are classified according to the degree of pollution based on the maximum allowable concentrations of chemicals in the soil (MPC) and their background composition. According to the degree of pollution, the soil is divided into:

1) heavily polluted - soils where the amount of pollutants exceeds the maximum permissible concentration by several times, such soils have low biological productivity, physicochemical and biological properties change significantly, as a result of which the content of the chemical in the standards established for the substance of crops will be excessive;

2) moderately polluted - exceeding the maximum permissible concentrations without significant changes in the composition of the soil;

3) less polluted - the content of chemicals does not exceed the MPC, but is higher than the natural background.

Also, samples taken for the presence of heavy metals were analyzed in the places where background soil pollution was determined - the Samarkand City National Park. The average amount of manganese, copper, nickel and cadmium in the soils of the Youth Garden (Table 1) is 0.2-1.0 MPC, zinc and lead - 1.2-1.5 MPC. According to the results of observations, it was found that the soils of the city of Samarkand, the background territories belong to the "permitted" category of pollution, and the total indicator of soil pollution of the "Youth Park" is ZF = 3.

Table 1

Average and maximum contamination of metals in the soils of the study area [2].

Metal	Average content		Maximum content	
	In units of maximum permissible concentration (MPC)	In background units	In units of maximum permissible concentration (MPC)	In background units
Manganese	0.2	0,5	0.2	0,6
Lead	1.5	2.0	1.9	2.8
Cadmium	1.0	1.2	1.6	2,0
Copper	0,7	1,5	1.1	2.2
Nickel	0,9	1.1	1.8	2.0
Zinc	1,2	1.5	1.7	2.1
Aluminum		1.1		1.2

The level of resistance of soils to chemical pollutants is assessed in relation to a specific component of a chemical pollutant or a group of substances polluting the soil under study. According to the level of resistance to chemical pollutants, soils are divided into: very resistant, moderately resistant, unstable types.

CONCLUSION: Pollution of the environment, especially the soil cover, with chemicals occurs under the influence of various factors, radioactive elements, heavy metals (Cd, Pb, Sr, Ni, As, etc.) gases and pesticides enter the soil cover and exert their influence through the "biochain of life » along the chain soil → plant → animal → human.

When studying the distribution of heavy metals in the environment, including the ways of their entry into the human body (intensive gardens located along the M37 highway), it was found that industrial waste and its dust play an important role.

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