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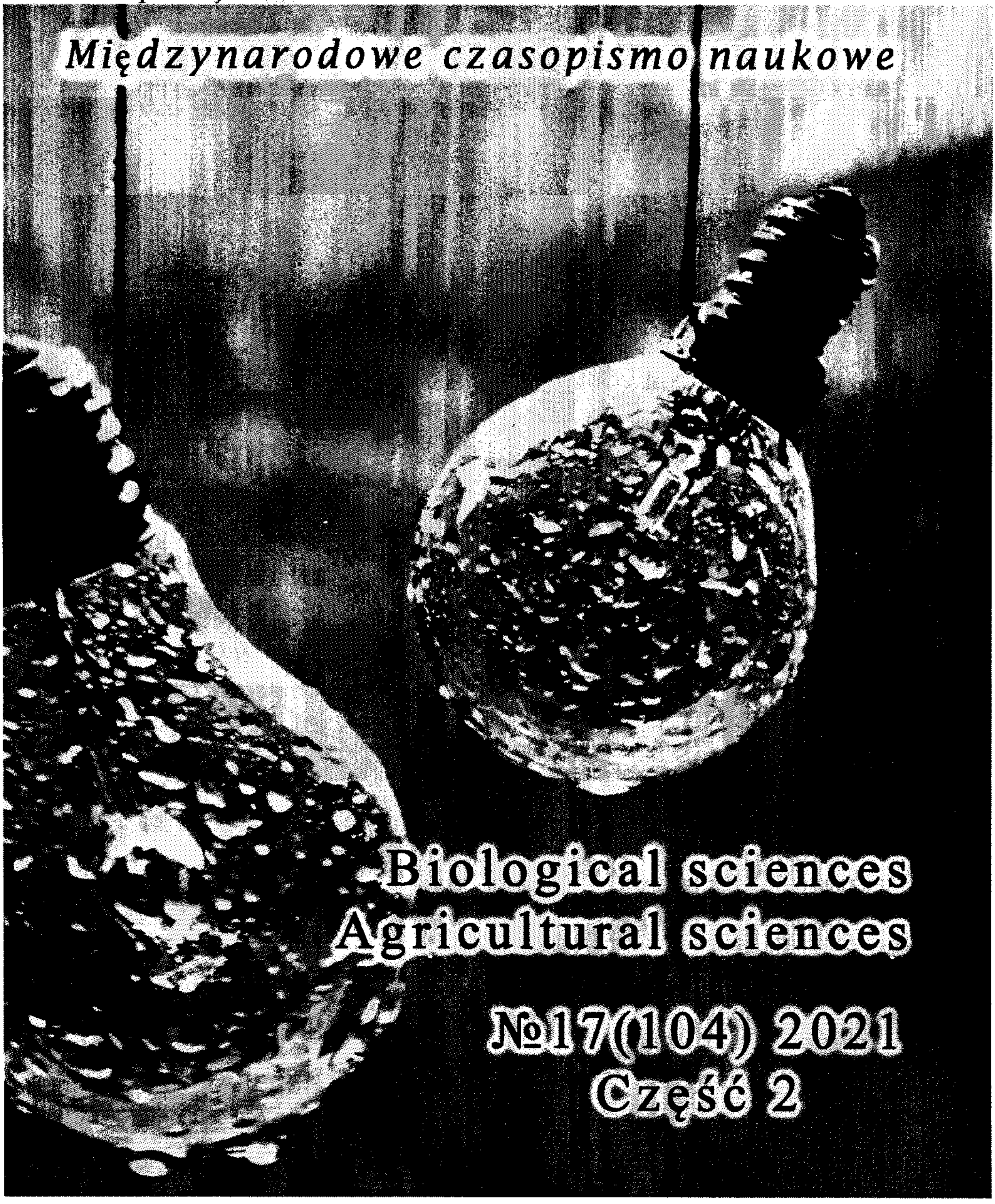

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INTENSITY OF AGGRESSION OF AGRICULTURAL LAND BY HEAVY METALS WITHIN THE FRESH-STEPPE FOREST BANK

Abstract.

The current state of the soil cover is determined primarily by the activities of human society. This factor is today in the first place among the factors transforming the soil cover of the planet. Intensification of agriculture, increase of technogenic load on land resources, uncontrolled use of chemicals in conditions of low technological culture and other influences lead to deterioration of soil quality, reduction of their fertility. Contamination of the atmosphere, water and soil with heavy metals is a very serious problem, because most cultural landscapes are affected by them, which in turn affects both crop productivity and product quality. Analysis of heavy metal contamination of meadows and pastures showed that the maximum permissible concentrations of lead, cadmium, zinc and copper were not detected. Thus, the concentration of lead, cadmium, zinc and copper in the soil of meadows was lower than the maximum allowable concentrations of 120; 7.7; 2.5; and 18.7 times. Less lead, cadmium, zinc and copper were found in pasture soils, respectively, in 113; 1.08; 1.09 and 1.88 times compared with the maximum allowable concentrations.

Our studies have shown that the content of lead and copper in arable land is 1.03 and 1.20 times higher, respectively, compared to the maximum allowable concentrations. And the concentration of cadmium and copper is lower by 11.66 and 2.16 times, respectively, compared to the maximum allowable concentrations. In the soils of perennial grasses, a lower concentration of lead, cadmium, zinc and copper, respectively, was found in 1.25; 1.84; 4.25 and 1.05 times compared to the maximum allowable concentrations.

Keywords: *Agricultural lands, heavy metals, pollution, arable land, meadows, pastures, perennial grasses, lead, cadmium, copper, zinc.*

The territory of Ukraine is characterized by a unique set of physical-geographical, landscape, hydrological, structural-geological and other parameters, which led to the formation within it of a significant number of species and objects of natural resources. According to the Council for the Study of Productive Forces of Ukraine, the most valuable among natural resources are land (72%) and mineral resources (26%). Ukraine's land fund is characterized by an extremely high rate of agricultural development (71.2%). In the structure of agricultural lands, the predominant share is occupied by agricultural lands (69.12% of the total area), and the plowed territory of Ukraine is 53.8%. Significant length of the territory of Ukraine from west to east and north to south, location in several natural and geographical areas causes significant differences in the structure of land resources in different administrative entities. There are more than 38 types of soils in Ukraine. They differ in structure, mineral composition, content of humus and nutrients, physical and chemical properties, fertility, suitability for agricultural use [4].

In the Forest-Steppe zone of Ukraine the soils occupy 20105.2 thousand hectares. Prolonged exposure to anthropogenic factors caused a high degree (75-85%) of plowing of agricultural lands, imperfection of technologies for growing crops, contamination of agrocenoses with heavy metals, pesticides and nitrates, as well as other negative processes, led to the deterioration of agronomy.

The consequence of the negative effects of anthropogenic impact is the deterioration of the ecological function of the soil in the ecosystem. The processes of compaction and violation of water-air and nutrient regimes are developing.

Agricultural land occupies 42 million hectares, or 70% of the total fund of the country. 78.9% of agricultural land - arable land (arable land) and perennial plantations, 13.0% - pastures, 8.4% - hayfields. The highest share of arable land - in the steppe areas (70 - 80%) and forest-steppe zone. Pastures are concentrated mainly in the Carpathians, Polissya and in the south-eastern steppe regions, hayfields - in the river valleys of the forest and forest-steppe zones [10].

Ukraine is characterized by a high degree of land development; agricultural land accounts for 60% of its area. A characteristic feature of the structure of agricultural lands of Ukraine is the total high share of plowed land (80%), and in Kirovohrad, Vinnytsia and Ternopil regions it is about 90%. Other areas are used for perennial plantations (1.5%), hayfields (3.1%) and pastures (11%). The structure of agricultural land is influenced by natural, economic and social factors. Thus, the lands of the forest-steppe zone are plowed by 85.4%, the lands of Polissya - by 68.9% (here almost a third of the area of agricultural lands is occupied by natural forage lands).

The basis of sown areas of Ukraine are crops of grain crops (56%). They play a leading role in all regions of Ukraine, especially those located in the steppe and forest-steppe zones.

Ukraine ranks one of the first places in the world in terms of agricultural land. The largest area of arable land is occupied by crops of cereals, especially winter wheat. Growing cereals has a latitudinal zonation. Thus, crop production and animal husbandry are well developed in Ukraine. All temperate crops are grown in Ukraine, and the main branch of animal husbandry in Ukraine is cattle breeding.

The current state of the soil cover is determined primarily by the activities of human society. This factor is today in the first place among the factors transforming the soil cover of the planet. Although natural forces do not cease to act on the soil, the nature of their impact changes significantly. Ways and means of human influence on the soil are diverse and depend on the level of development of the productive forces of human society [6].

Of all soil types, the most fertile are chernozems. Soil fertility is determined by a component such as humus (humus). It is an organic substance formed from the remains of dead organisms, as well as as a result of the activity of organisms that process these remains, decompose, enrich with carbon dioxide, water, ammonia and other substances. The process of soil formation (soil formation) is an important part of the biological cycle of substances and energy. The soil provides plants with potassium, carbon, nitrogen, phosphorus, etc.

The largest area is occupied by the so-called ordinary chernozems - 10.5 million hectares, typical chernozems are 5.8 million hectares, southern - 3.6 million hectares, podzolic - 3.4 million hectares. In addition to chernozems, fertile soils are sod-podzolic, chestnut solonetzic, brown soils, sandy, meadow and others.

Agricultural lands are formed according to the wishes and needs of man. They operate within areas where anthropogenic activity is leading and has significantly changed the habitat. Therefore, the general chemical and physical pollution of the environment determines the conditions for the development of agroecosystems.

The following aspects of the impact of anthropogenic activities on agricultural land can be identified:

- global climate change caused or exacerbated by anthropogenic activities to which it is necessary to adapt;
- the impact of polluted air on vegetation;
- development of plants on soils contaminated with heavy metals and radionuclides;
- long-term impact of pesticides on agroecosystems;
- irrigation as a risk factor for soil condition;
- the impact of animal husbandry on the environment;
- changes in agroecosystems due to indirect human action on associated species [3].

Among the lands of the greatest economic value are agricultural lands. The structure of land is the percentage of their area in the total area of all, or only agricultural land. The composition and ratio of land do not remain unchanged. Areas of land that have not been cultivated before are involved in the production of agricultural products. In particular, swamps are drained, shrubs are uprooted for growing crops. That is, there are processes of land transformation.

Intensification of agriculture, increase of technogenic load on land resources, uncontrolled use of chemicals in conditions of low technological culture and other influences lead to deterioration of soil quality, reduction of their fertility. The main reason is that intensive agricultural technologies have contradicted the functioning of ecosystems, disrupted the natural cycle of substances and energy in them.

An urgent problem today is the study of the accumulation of heavy metals in soils. Soil contamination is the process of introducing or creating new physical, chemical or biological agents in the soil, or exceeding the average long-term natural level of concentration of these agents over a period of time [9].

Among the pollutants on the scale of pollution and impact on biological objects a special place is occupied by heavy metals, which play an important role in metabolic processes, but in high concentrations cause soil contamination, adversely affect agroecosystems. Toxic effects of heavy metals can be direct or indirect. The danger posed by heavy metal contamination is exacerbated by their poor removal from the soil.

Once in ecosystems, heavy metals are constantly moving, moving from one form to another. There are the following systems of transition (translocation) of heavy metals: air - soil, soil - water; soil - a plant; soil - plant - animal; soil - animal - plant - man; soil - plant - man, etc. Heavy metals accumulate mainly in its upper horizons, which contain most of the roots of plants. The content of various elements in the soil is significantly influenced by the atmosphere. The elements that are released into the atmosphere through the pipes of the chemical, heavy and energy industries, emissions from vehicles have a significant impact on the environment, and their effect extends tens of kilometers from the source of income. The use of mineral fertilizers helps to increase all the necessary elements for plant growth and development [5].

Heavy metals in mineral fertilizers are natural impurities contained in agricultural ores. Therefore, their number in mineral fertilizers depends on the raw material and technology of its processing. Every year the area of soils suitable for agriculture is reduced. Improper land use, pollution by industrial, agricultural and household waste have intensified degradation processes in the soil. In order to obtain systematic objective information about changes in soil condition, identify their causes and development trends, optimize human impact on the soil cover form a system for monitoring the condition of soils.

The most valuable component of agricultural land is arable land, which is characterized by the presence of soil cover, which ensures fertility. Arable land plays the role of the main means of production in the cultivation of grain, technical, etc. Cultures [4].

Arable land is land that is systematically cultivated and used for crops. Also arable land includes pure pairs, crops of perennial grasses in crop rotation fields with the term of use provided by crop rotations, as well as hatching fields. Rows of gardens and other perennials that are temporarily used for crops are not included in the area of arable land, but are accounted for as areas of perennials. Areas of cultivated hayfields and pastures plowed for the period of grassland renewal, as well as occupied by crops of previous crops (not more than two years), plowed for the purpose of creating long-term pastures or improved hayfields do not belong to arable land.

Pastures - land covered with perennial grasses and not suitable for haymaking, are not fallow and are systematically used for grazing. The areas of feeding and quarantine plots, as well as areas of cattle runs are taken into account for pastures. Pastures are divided into dry and swampy.

Meadows - a plot of soil in conditions of sufficient or excessive moisture, covered mainly with perennial herbaceous plants, mainly cereals and sedges. It is usually used as pasture for livestock and as hayfields. All meadows are characterized by the presence of grass and turf.

Meadows are classified by location on the mainland, mountain and floodplain.

The best and most productive meadows are in river valleys, where trees cannot grow through surface waters [11].

Perennial grasses are plants that live for more than two years. Biological factors such as improving the structure of soils and increasing their fertility through enrichment with available nitrogen should also be taken into account. Perennial grasses are a good precursor for all crops. Leaching of eroded lands with perennial grasses is one of the effective means of combating erosion and improving the ecological situation.

In the group of perennials can be distinguished legumes (clover, alfalfa, white clover, Ukrainian ladvenets) and cereals (buckthorn, red fireweed, foxtail, giant broom, tall ryegrass, boneless barberry, meadow thyme, etc.) in a mixture with legumes (in its pure form - mainly on seed areas.

Harmful anthropogenic impact, as well as the rampant elements, natural and man-made, cause enormous, sometimes irreparable damage to the soil. These are, first of all, water and wind erosion, deterioration of soil structure, mechanical destruction and compaction of soil, constant depletion of humus and nutrients, soil contamination with mineral fertilizers, pesticides, lubricants and fuels, waterlogging and salinity.

Over the last few decades, the intensity of soil contamination with harmful substances has been growing rapidly due to the high level of chemicalization of agricultural production. All this negatively affects the quality of food raw materials, which in turn increases the incidence of the population. Therefore, the issue of studying the condition and ecological safety of soils is relevant today.

Contamination of the atmosphere, water and soil with heavy metals is a very serious problem, because most cultural landscapes are affected by them, which in turn affects both crop productivity and product quality. The source of heavy metals entering the soil can be precipitation, which may contain lead, cadmium, arsenic, mercury, chromium, nickel, zinc and other elements. The largest source of heavy metals is industry. Heavy metals enter the atmosphere in the form of aerosols, dust, solutions in wastewater and debris. Heavy metals in mineral fertilizers are natural impurities contained in agricultural soils [2].

Pollution of agro-ecosystems by heavy metals is an extremely important and urgent problem today. Their danger is determined by the ability to accumulate in the soil, join the food chains and be transmitted by them from plants to the human body.

Soil protection is a very acute problem, which is directly related to the issues of yield and food security. It is necessary to increase fertility and maintain the resilience of the biosphere. Soil analysis for heavy metals is included in the list of measures for environmental monitoring of soils. Heavy metals adversely affect plants, animals and soil microflora. Currently, heavy metals are considered one of the main pollutants in the ecosystem. In the conditions of intensive anthropogenic influence their hit in agroecosystems exceeds its protective properties.

Contamination of the soil with heavy metals leads to a decrease in yield and quality of agricultural products. Heavy metals in arable soils also pose a serious threat to human health, as they enter plants from the soil and from them into the body.

Heavy metals are present in the soil as natural impurities, and the reasons for the increase in their concentrations are related to human activities. In recent decades, due to the rapid development of industry, there has been a significant increase in their content in the biosphere, atmosphere and hydrosphere, so they are now one of the priority polluters of land resources. Under conditions of intense anthropogenic impact, the inflow of heavy metals into the agroecosystem exceeds its protective (buffer) properties. This reduces the yield and quality of crop products, making it dangerous for humans and animals [9].

Depending on the type of source and properties, there are two types of heavy metals:

1) lithogenic, ie associated with the parent breed;

2) anthropogenic, ie those that fall into the soil as a result of human activities.

Heavy metal pollution is mainly local. The most polluted areas are found near industrial centers, large industries, construction of highways.

Once in the soil, heavy metals constantly migrate, turning into one or another form of chemical compounds. Some of them are subject to hydrolysis, others can form sparingly soluble compounds and become fixed in the soil. Heavy metals in the soil can be in three states: non-exchangeable, exchangeable, water-soluble. Moreover, all types of soil absorption capacity take part in the processes of accumulation and transformation of metals.

Plants, like all living organisms, can counteract the increase in the concentration of heavy metals only to a certain extent. And a further increase in their concentration leads to the suppression and death of living organisms. The accumulation of heavy metals in the upper layers of the soil results in the depletion of the species composition of plants and microorganisms and the deterioration of the conditions of growth and development of cultivated plants.

Soil pollution is the result of economic activity in the past and 2 now.

The soil is most often contaminated with metal compounds and organic substances, oils, tar, pesticides, explosives and toxic substances, radioactive, biologically active combustible materials, asbestos and other harmful products. The source of these compounds is most often industrial or domestic waste, buried in certain places, or unauthorized landfills [8].

In Europe, the problem of unauthorized landfills for household and industrial waste deserves priority. The cost of tackling the effects of environmental pollution in Europe is more than 10 billion euros.

Soil contamination with heavy metals such as mercury, cadmium, lead, chromium, copper, zinc and arsenic (arsenic) is quite dangerous. Heavy metals are present in the soil as natural impurities, but the reasons for the increase in their concentrations are related to:

• industry (non-ferrous and ferrous metallurgy, energy, chemical industry),

• agriculture (irrigation with contaminated water, use of herbicides),

• incineration of fossil fuels and waste,

• by motor transport.

Contamination of agricultural land with heavy metals leads to reduced yields and increased content in agricultural products [7].

The increase in the amount of heavy metals in meadows occurs mainly in the surface (up to 5 cm) layers of soil. They are directly consumed by animals during grazing.

Heavy metals are toxic and interfere with the activity of soil microflora. Their concentration in the soil can persist for decades and even centuries.

Reducing emissions of heavy metals is the most affordable way to limit their impact on soils. Even if the number of cars increases, in the case of using gasoline without harmful impurities), you can reduce lead emissions.

In Central and Eastern Europe, industrial emissions of heavy metal compounds still remain significant [3].

The introduction of comprehensive measures to limit soil acidification can effectively reduce emissions of heavy metals. The amount of heavy metals in the soil can be reduced by using low-metal fertilizers, replacing inorganic pesticides with organic products, and using other methods. The source of heavy metals in soils are:

a) parent breed;

b) precipitation (dust, rain);

c) biological material - organic matter.

Depending on the type of source and properties of heavy metals in the soil, there are two types of heavy metals:

1) lithogenic, ie associated with the material of the parent breed;

2) anthropogenic, ie those that fall into the soil as a result of human activities.

In the second case, the adsorption properties of the soil are very significant. They are due to its specific structure: it contains micelles of mineral or organic colloids and soil solution. Micelles of soil colloids usually have a negative charge, which facilitates the exchange adsorption of the deposition of heavy metal ions from the soil solution to the diffusion layer of the micelle. The adsorption properties of the micelle depend on both the type and structure of the colloid and the nature of the cation. The highest adsorption capacity, which is defined by the so-called adsorption capacity (the total number of cations, which on the diffusion layer is expressed in milliequivalents, ie, per 100 g of soil), is inherent in organic colloids [1].

Depending on the content of organic matter in the soil, it, due to changes in the adsorption capacity, changes the content of heavy metals, which is considered natural. The adsorption capacity of the cation increases with its valence and depends on the radius of the metal ion in the anhydrous and in the aqueous state.

The total adsorption capacity of the soil is influenced by the possibility of exchange adsorption arising from isomorphic substitution of ions, regardless of pH, as well as the possibility of additional adsorption associated with the dissociation of protons of active groups. The last of these processes largely depends on the pH, ie the acidity of the soil. Due to the increasing acidity of soils under the influence of anthropogenic processes, the share of acid soils with the pH of the soil solution below 4.65 increases. In such soils, the adsorption capacity changes, which leads to an increase in the concentration of some forms of heavy metals in the soil solution [6].

The cations adsorbed to the diffusion layer of the colloid are exchanged with the cations of the soil solution. The ease and rate of cation exchange depends on the type of other cations in the adsorption complex, as well as on the type of anions present in the soil solution. Cations that form sparingly soluble or volatile compounds with anions present in the soil solution are more easily released from the adsorption complex. Thus, adsorption processes are accompanied by precipitation processes - dissolution of salts of heavy metal ions and much less often - oxidation processes.

The most dangerous heavy metals that contaminate soils, food and feed are lead, cadmium, zinc, copper and others. Approximately 90% of heavy metals entering the environment are accumulated by soils.

In the soil, lead is a very weak migrant. Lead is very easily adsorbed by sludge minerals, iron and aluminum hydroxides, as well as organic substances. It is released from the soil solution in the form of carbonates and phosphates, which indicates its stable location in the soil, in particular where the soil pH is greater than 6.5. After changing the pH of the soil towards acidic, mobile hydrocarbonate forms of $PbHCO3^{+}$ appear, as well as organic complexes.

Also, the increasing acidity of the environment causes the formation of chemical forms of lead, which are relatively soluble [2].

Cadmium. The impact of cadmium on the environment is evidenced by the following properties: existence in soluble form; ability to accumulate by plants; similarity of physicochemical properties of Cd (II) to the properties of Ca (II), which makes it possible to replace calcium with cadmium; very high migration capacities in water and water-soil environment. Forms of cadmium in the soil. Cadmium acts in a soluble form, does not form independent deposits of minerals. Accompanies zinc ore. It is present in natural phosphates and apatites in such quantities that it can be obtained in superphosphates extracted from apatites. In soils with a high pH value (alkaline) and a significant substitution capacity, cadmium cations become immobile.

Zinc. The average zinc content in soils is 17–125 mg / kg. It is considered that Zn is the most soluble heavy metal (concentration in soil solutions is 4-270 mg / l). Analyzing the toxic effects on plants and microorganisms, it should be noted that a direct linear relationship between the zinc content in the soil and its absorption by plants. It is concentrated mainly in mature leaves. Most plant species are tolerant of excess Zn, but often observe phytotoxicity. The level of zinc, which reduces the yield or height of plants by 5-10% is considered toxic [4].

Copper belongs to the group of highly toxic metals. Copper is one of the least mobile heavy metals, although the concentration in soil solutions is quite high - 3-135 mg / l. Toxic effects on plants: there is a direct relationship between the copper content in the soil and its uptake by plants. Despite the significant role of copper in many physiological processes and high tolerance of plants, this element is considered very toxic (twice as toxic as zinc): an excess of $Cu2^{+}$ and Cu^{+} leads to tissue damage, elongation of root cells, changes in membrane permeability, lipid peroxidation in chloroplast membranes and inhibition of electron transfer during photosynthesis. Antioxidant protection of cells is suppressed. It passes very slowly into plants: an increase in the soil 12 times leads to an accumulation in tubers, grains, straw, leaves at most twice. The copper concentration of 60 mg / kg is considered excessive, which can lead to chlorosis in plants. Threshold concentrations for plants: for cereals - 10, legumes - 32 mg / kg of dry matter. MPC in grain - 100; in vegetables and fruits - 10 mg / kg. Toxic effects on soil microflora, copper and its compounds are quite toxic to soil microflora. Contamination of 3 mg / kg or more of sandy soil leads to inhibition of the activity of nitrifying bacteria [8].

To reduce the harmful effects of heavy metals, appropriate standards for their content are introduced:

1. MPC of gross content of heavy metals in the arable layer of soil and plant mass;

2. MPC of mobile forms of heavy metals in soil, mg / kg;

3. Clark of heavy metals in soil, mg / kg.

The MPC of heavy metals is their concentration, which when exposed to soil and plants growing on it for a long time does not cause any pathological changes or anomalies of biological processes, and does not lead to the accumulation of toxic elements in crops and, accordingly, cannot violate the biological optimum for farm animals and humans [3].

The degree of contamination of soil and plants with toxic elements and compounds in the conditions of intensive chemicalization is a new, rather urgent ecological problem. Therefore, it is difficult to choose the right method for determining heavy metals in the soil, as well as the method for determining the toxic level of heavy metals in the soil. Extensive methodological work is needed to select the most objective methods for determining toxic elements in the soil.

It is in the soil that it is necessary to normalize the content of heavy metals, as soils affect the chemical composition of natural waters, air, plants, products of animal origin, and therefore human health. The introduction of the MPC unit will help to unite the efforts of different states in the field of environmental protection from pollution. Standardization of the content of heavy metals in soils involves the establishment of their maximum allowable concentrations (MPC) [5].

Soil protection is a rather acute problem, directly related to the issues of yield and food security. It is necessary to increase fertility and maintain the resilience of the biosphere. Soil analysis for heavy metals is included in the list of measures for environmental monitoring of soils. Heavy metals adversely affect plants, animals and soil microflora. Currently, heavy metals are considered one of the main pollutants in the ecosystem. In the conditions of intensive anthropogenic influence their hit in agroecosystems exceeds its protective properties.

Arable land is intensively used for crops, as a result of which it is annually exposed to intensive pollution by various harmful substances, including heavy metals. The main sources of arable land pollution are mineral fertilizers, herbicides, pesticides and others.

Table -1

Soil pollution by heavy metals, mg / kg

Heavy metals	MAC	Soils			
		Meadows	Pastures	Arable land	Perennial grasses
Lead	6,0	0,05	0,053	6,2	4,8
Cadmium	0,7	0,009	0,0097	0,06	0,38
Zinc	23	9,0	9,8	10,6	5,4
Copper	3	0,16	0,3	3,61	2,84

Analysis of heavy metal contamination of meadows and pastures showed that the maximum permissible concentrations of lead, cadmium, zinc and copper were not detected. Thus, the concentration of lead, cadmium, zinc and copper in the soil of meadows was lower than the maximum allowable concentrations of 120; 7.7; 2.5; and 18.7 times. Less lead, cadmium, zinc and copper were found in pasture soils, respectively, in 113; 1.08; 1.09 and 1.88 times compared with the maximum allowable concentrations.

Our studies have shown that the content of lead and copper in arable land is 1.03 and 1.20 times higher, respectively, compared to the maximum allowable concentrations. And the concentration of cadmium and copper is lower by 11.66 and 2.16 times, respectively, compared to the maximum allowable concentrations. In the soils of perennial grasses, a lower concentration of lead, cadmium, zinc and copper, respectively, was found in 1.25; 1.84; 4.25 and 1.05 times compared to the maximum allowable concentrations.

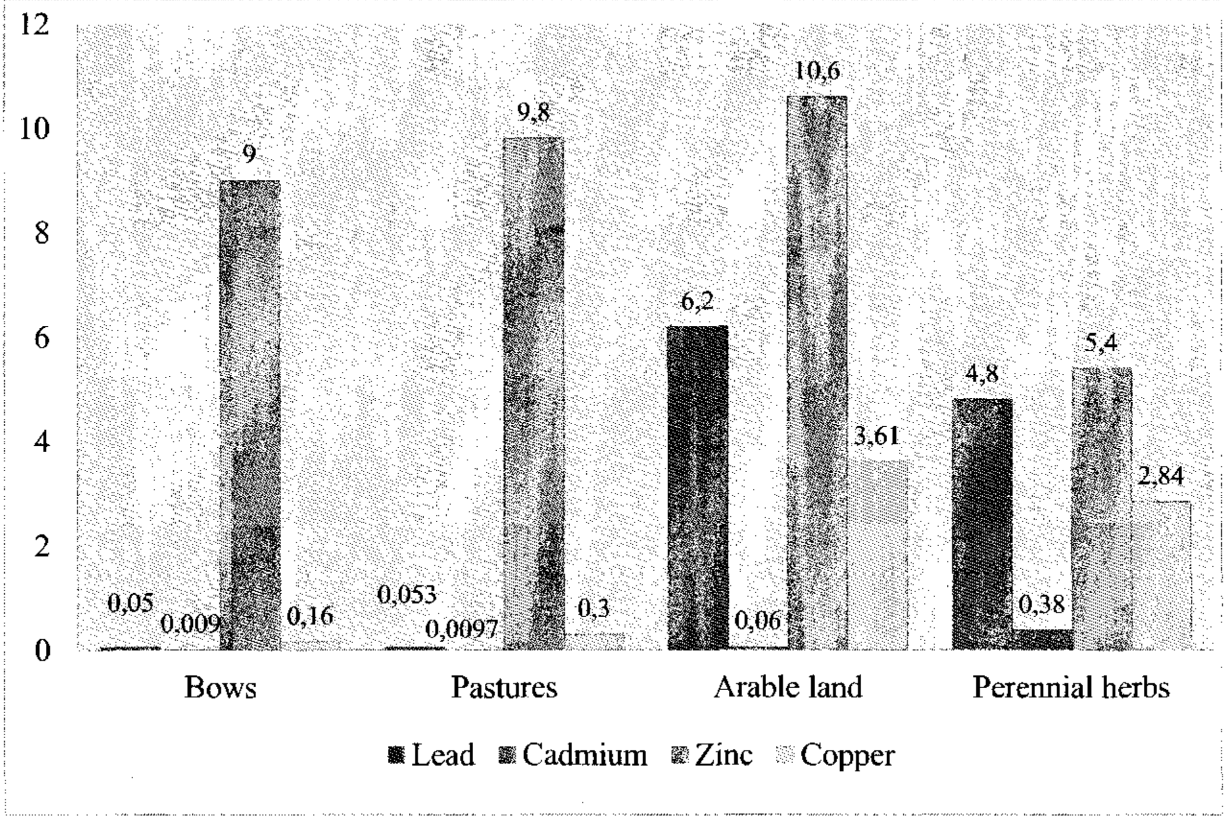

Fig. 1. Comparative characteristics of heavy metals in soils, mg / kg

In addition, it should be noted that the soils of meadows, which are located mainly in the lowlands and ravines, contain more lead, cadmium, zinc and copper. In particular, in the soil of meadows there was a higher content of lead, cadmium, zinc and copper, respectively, in 1.06; 1.08; 1.09 and 1.88 times compared to the soil of pastures.

The highest concentration of heavy metals in the soil was zinc, the lowest - lead. At the same time, it should be noted that this trend was observed in soils from meadows and pastures.

Also, the concentration of cadmium in arable land was 6.33 times lower than the concentration of the same heavy metal in the soils of perennials. And the concentration of lead, zinc and copper in arable land was higher by 1.29, respectively; 1.96 and 1.27 times compared to perennial grasses.

There are several ways to reduce the content of heavy metals in the soil.

1. Removal of the top layer of soil. This is possible if there is atmospheric contamination of the soil with heavy metals, and toxic substances are concentrated in the upper centimeters of the soil.

2. The use of inactivating chemicals that reduce the toxic effects of heavy metals. Such substances are, for example, ion exchange resins.

3. Lime and organic fertilizers adsorb heavy metals in the soil.

4. Application of large doses of some mineral fertilizers (eg, phosphorus) reduces the toxic effects of lead, copper, cadmium, zinc.

But the most effective way to combat soil contamination with heavy metals is prevention. Improving technologies and principles of production at enterprises can reduce harmful emissions into the environment and avoid pollution [2].

The potential danger of heavy metals and their accumulation in the environment, including in the soil, requires the use of various measures to prevent the entry of toxicants into the soil for agricultural purposes. Mineral fertilizers are a powerful source of soil contamination with heavy metals.

The main measures that prevent and reduce the amount of heavy metals in agricultural soils are: optimal doses of fertilizers in crop rotation for each crop, the correct timing of fertilizer taking into account the biological characteristics of the crop, soil properties, climatic characteristics of the growing region and forms of fertilizers, use of one or another technology in crop production.

The application of these measures will significantly improve the environmental situation in the field of agro-industrial production and the environmental situation in general [10].

The implementation of measures to improve the quality of the natural environment in the field of agro-industrial production has formed the basis of environmentally friendly production and is based on the following principles:

- care for maintaining soil fertility;
- use of organic fertilizers, greens and crops of perennial legumes;
- application of mineral fertilizers and chemical reclamation on a strict scientific basis;
- increasing the share of biological methods of weed and pest control;
- comprehensive measures to prevent soil erosion;
- limited use of heavy equipment.

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МОРФОЛОГІЧНІ ПОКАЗНИКИ КРОВІ МОЛОДНЯКУ ШИНШИЛ ПРИ РІЗНИХ СИСТЕМАХ УТРИМАННЯ

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MORPHOLOGICAL BLOOD PARAMETERS OF YOUNG CHINCHILLAS UNDER DIFFERENT HOUSING SYSTEMS

Анотація.

При вивченні впливу кормових факторів на підвищення продуктивності молодняку шиншил важливе значення мають дослідження морфологічних та біохімічних показників крові. Завдяки своїй рухливості кров є зв'язуючим елементом між усіма органами і тканинами тіла, а хімічні речовини і продукти життєдіяльності різних органів (гормони, ферменти) здійснюють взаємний вплив один на другого також через кров. Рухаючись і пульсуючи по замкнутому колу, вона омиває всі органи і тканини. Тому картина крові є симптоматичним відображенням змін в інтенсивності перебігу усіх обмінних процесів, що проходять в організмі тварин під впливом певних кормових факторів.

Дослідження проводились в умовах віварію на молодняку шиншил в період закладки зимового хутра. З молодняку шиншил було сформовано три дослідні групи, по 4 звірів у кожній.

В результаті досліджень встановлено, що введення до раціону молодняку шиншил нового кормового фактору суттєво не вплинуло на кількісний склад формених елементів крові, кількість гемоглобіну, але сприяло вірогідному підвищенню в другій та третій групах кольорового показника.

На лейкоцитарну формулу препарат особливо не вплинув, лише викликав підвищення кількості еозинофілів та юних форм нейтрофілів у другій групі.

Вміст кальцію, фосфору та лужний резерв залишився без змін. Так само препарат не вплинув і на вміст білка та кількість альбумінів і глобулінів, винятком є третя група, де зафіксовано зниження кількості γ-глобулінів.

Abstract.

When studying the effect of feed factors on the increase of productivity of young chinchillas, it is important