ЗЕМЛЕДЕЛИЕ, АГРОХИМИЯ, КОРМОПРОИЗВОДСТВО, АГРОЭКОЛОГИЯ, ЛЕСНОЕ ХОЗЯЙСТВО

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T.S. Abzhanov, B.A. Kentbayeva

The Kazakh National Agricultural University

ECOLOGICAL AND BIOLOGICAL CHARACTERISTICS OF HEAVY METALS ACCUMULATION IN LAMINAS OF WOODY PLANTS ASTANA SITY

Abstract: Heavy metals that were included in the scientific literature in the middle of the last century under such a negative name, at current stage already occupy the second place in the hazard level. In the future they might become the most hazardous or even more hazardous than APS and solid wastes. Contamination with heavy metals occurs due to their wide use in industry, causing them to fall into the environment bringingenormous damage.

Key words: heavy metals,“Acid rains”, sanitary norms and rules

Heavy metals having a density greater than 5 g/cm3 with a relative atomic mass of more than 50 refer to priority pollutants which monitoring are required in all environments. There are 78 heavy metals on earth, and their total weight does not exceed 1.2 % of the total weight of the lithosphere. Mostly soil is contaminated with such heavy metals as iron, manganese, copper, zinc, molybdenum, cobalt, mercury, lead, cadmium, etc., that are known as microcells, required to plants in small amounts.

Human activity always brings to formation of numerous volumes of waste, including toxic. Industrial enterprises and large number of vehicles - obligatory accompanimentsof urban environment are the major and permanent “suppliers” of toxic waste into the atmosphere. Under normal conditions, heavy metals are contained in soil in small quantities and are not hazardous. However, their concentration may increase due to vehicle exhaust, waste, residues and emissions during operation of industrial plants, during fertilize, etc. Accumulation in the soil of toxicants and products of their interaction with inorganic and organic components leads to a change in its chemical composition and physical mechanical properties, so that the soil itself may be toxic environment for the growth and development of plants. Excess of these elements or existence of certain particularly toxic elements even in very small amounts can cause depression and loss of plants[1].

However, as indicated above, it should be noted that heavy metals in certain concentrations are necessary for living organism (microelements). Therefore they must be distinguished by the degree of negative impact on organisms. All microelements may adversely affect the plants, if concentration of their available forms exceed certain limits. Some heavy metals, e.g., lead and cadmium thatwestudy are hazardous even at low concentrations. Adverse effect of heavy metals depends substantially on their mobility, i.e. solubility. Migration of heavy metals in soils can occur with liquid and slurry through the plant roots or soil microorganisms. Migration of soluble compounds occurwith the soil solution, or by moving the liquid itself. Washout of clays and organic matter leads to a migration of the associated metals. Heavy metals can be imported or adsorbed by microorganisms which in turn are able to participate in the migration of respective metals.

Heavy metals can be induced or adsorbed by microorganisms which in turn are able to participate in the migration of respective metals. Earthworms and other organisms can contribute to migration of heavy metals by mechanical or biological means, mixing the soil or including metals in their texture. The most importanttype of migration of all migrations is migration in the liquid phase, because most metals get to soil in a soluble form or as aqueous slurry and in fact all of the interactions between the heavy metals and liquid components of the soil occur at the border of the liquid and solid phases.

Heavy metals have the greatest mobility in acid soils, as in acid soils poorly soluble metallic oxides and phosphates pass into the ionic form which is easily digestible by plants. Increase of soil acidity to 1.8-2 units (range of pH variation for soil is 4-6.5) results in increased mobility of lead ions in 3-6 times, cadmium - 4-8 times, which in turn accelerates the penetration of heavy metals ions in the cell plants.

“Acid rains” often falling near major industrial cities increase plants pollution by heavy metals. One mature tree during the growing season neutralizes lead contained in 130 liters of leaded fuel. Dust can contain up to 1 % lead.

The soil and plants are contaminated as a result of transport (road, rail and air), as well as enterprises of machine building, metalworking, chemical and energy industries. For example, lead gets to the atmosphere and soil from the exhaust gases of internal combustion engines. Cadmium, lead gets as a result of tire wear [2].

Heavy metals in the soil get to plants through the food chain. Various biological barriers exist in heavy metals cycle, whereby selective bioaccumulation occurs that protect organisms from the excess of these elements. Yetactivity of biological barriers is limited and heavy metals are often concentrated in the soil. Resistance of soils to contamination is different depending on the buffercapacity. Among the most dangerous toxic elements lead, cadmium, mercury and zinc, belonging to the first class of hazard (GOST 17.4.1.02-83) should be allocated. According to SanPin 2.3.2.1078-01 regulating the content of toxic elements (lead, arsenic, cadmium and mercury) in plant-based BAAs (teas), the maximum permissible level of lead is 6,0 mcg/g. Maximum permissible levels of zinc in medicinal plant raw materials are not available, pergeneralized literary data, MCL of zinc in plants is 50 mcg/g, these figures are indicative[3,4].

The objects of research were the woody species introduced in Astana in the spring of 2012. The selection of woody species was carried out in view of growing plants in Astana, and introduced new plants must meet the biological and ecological characteristics of the new growing conditions.

On this basis, in 2012 we introduced the first group of plants consisting of 13 woody species delivered by vehicle from the JSC “Lesnoypitomnik” in Almaty region.

The first test site is located in the Presidential park near the Palace of Peace and Accord.

The second test site is located in the Lovers Park near the shopping center “Khan Shatyr”.

The third test site is located in the Student Park near the Kazakhstan Sports Centre.

Leaf selection for ecological and biological studies of heavy metals determination was carried out using an average sample method at the end of each species’ vegetation at each site. At least 10 leaves from each tree were selected. The heavy metal content in the leaves was determined by the dry mineralization, based on a complete decomposition of organic substances by incineration of plant samples in a muffle furnace at controlled temperatures.

For researchthe soil samples were taken from five blocks of Astana green belt located near highways and industrial enterprises. Test areas were separatedof each block: block № 50-5 areas, where the maximum number of test plants grow, and one test areain each other block.

For the analysis of heavy metals in soils - Zn, Cd, Pb- an atomic absorption spectrophotometer AA - 7000 “Shimadzu” was used. Atomic absorption spectrophotometer AA - 7000 “Shimadzu”joints two systems of background correction: D2 method (method of correction using a deuterium lamp) and the SR method (high-speed method of correcting for self-referral line), giving the opportunity to choose the appropriate method for the samplemeasurement. Metolcontent is determined by the value of integral analytical signal and was calculated by the pre-installed calibration dependence [5].

To prepare the soil for atomic absorption spectrophotometry, guidelines for the destruction of organic matter in the samples using a microwave system “Minotaur -2”PU 12-2009 were used. For this,1gof soil sample was placed in the rotor of “Minotaur 2” and was added to 9ml content of nitric acid and 1 ml of hydrogen peroxide. The prepared samples were placed in microwave system and were treated for 1 hour.

The lead content in the laminasin the first site changes in the following range 2.3458 mcg/g in Caraganaarborescens (f. pendula) and up to 5.2743 in Juglansmandshurica (variability limit - 2.9285 mcg/g), cadmium content - 0.6895 mcg/g inMahoniaaquifoliaand up to 1.7959 mcg/g for Juglansmandshurica (variability limit – 1.1100 mcg/g) (Table 1).

Lead is primarily a superficial deposit, while cadmium penetrates the leaves. Easier removal of lead by washing is due to the fact that this element is mainly present in the form of a precipitate on the leaves surface. On the contrary, it should be emphasized that duringlong flushing, metals are removed not only from the surface, but from the leaf tissue.

In the background conditions all woody plants are characterized by intensive accumulation of cadmium and lead due to the biological absorption from soils. It is believed that the lead concentration above 10 mcg/gof dry substance is toxic to most cultivated plants.

The lead content in the laminas of plants in the second site varies within the following limits: a minimum of 1.8775 mcg/g in Fraxinus excelsior L. and a maximum of 4.8527 mcg/g in Juglansmandshurica (variability limit - 2.98 mcg/g), cadmium - 0.5324 mcg/g in Mahoniaaquifolia and up to 1.5767 inJuglansmandshurica (variability limit - 1.0500 mcg/g). Diagram in Figures 2 and 3 clearly reflect these data.

There is a following picture on the third site: a minimum of 2.7547 mcg/g in *Phellodendronamurense* and a maximum of 6.1976 in *Juglansmandsh*urica (variation limit - 3.4500 mcg/g), cadmium - 0.8426 mcg/g in *Mahoniaaquifolia* and up to 1.8284 mcg/g in *Juglansmandshurica*(variability limit - 0.9900 mcg/g).

If we consider all the tested plants of the first site on the lead content, the average of all 13 testedtypes is 3.2300 mcg/g, for cadmium arithmetic average is 1.0100 mcg/g.On the second site the average lead content in laminasis 2.700 mcg/g, cadmium is 0.8900 mcg/g,on the third site the lead is 3.7400 mcg/g and cadmium is 1.300 mcg/g.

Table 1 - The heavy metal content in the leaves of introduced woody species (mcg/g)

№	Woody species	Site 1		Site 2		Site 3	
		Lead	cadmium	lead	cadmium	lead	Cad-mium
1	Caraganaarborescens (f. pendula)	2.3458	0.8910	1.9868	0.7614	2.9041	1.3756
2	Prunusdivaricate	2.9532	0.9529	2.2681	0.7963	3.2580	1.2151
3	Amorphafruticosa	3.4421	0.9232	2.6860	0.8211	3.8243	1.4943
4	Phellodendronamurense	2.5241	0.9253	2.3521	0.8640	2.7547	1.2975
5	Gleditsiatriacanthos	3.7593	1.0357	3.3866	0.9167	4.2418	1.2326
6	Salix babilonica	3.0914	0.9687	2.3574	0.8946	3.5478	1.3542
7	Acerginnala	3.6092	0.9223	2.6924	0.9045	3.8008	1.1903
8	Mahoniaaquifolia	2.6092	0.6895	2.0521	0.5324	3.1478	0.8426
9	Juglansmandshurica	5.2743	1.7959	4.8527	1.5767	6.1976	1.8284
10	Populussimonii	3.6852	1.2654	3.3577	1.0862	4.9347	1.5335
11	Forsythia xintermediaZabel	3.4652	0.9120	2.8865	0.8314	3.9241	1.5941
12	Padusavium	2.7609	0.8621	2.2584	0.7612	3.2145	0.9647
13	Fraxinusexcelsior L.		0.8904	1.8775	0.7802	2.8248	0.8860

Cadmium in the exhaust gases, the main source of its entrance in the plants is less than lead, but cadmium is many times more hazardous. If the lead can still be excretedfrom the organism, the cadmium can’t, it gradually accumulates inside of plants’bodies, especially in the roots. Major source of cadmium on the roads are the cars running on diesel fuel. Cadmium MAC in soil in different countries varies from 2 to 5 mg/kg, in fodder - 1 mg/kg.

So, ambiguous conclusion can be made on the above maximum and minimum values of sites: the arithmetic average of the maximum accumulation of heavy metals falls on the third site, followed by the first site and the minimum average total quantity of lead and copper in the leaves of all 13 speciesfalls on the second site.

Furthermore it should be noted that *Juglans mandshurica* laminashave the maximum accumulation of lead and cadmium, at least 50 % of Mahoniaaquifolia at all three sites.

The cadmium accumulation in laminas is important indicator of plant disease. Cadmium caught in leaves, can be easily moved. At first two eco-sites the cadmium content can be fixed as high. It is known that cadmium is accumulated bysoils and in plant organs. So, cadmium in all three areas isfrom 0.6895 mcg/g (the first site–*Mahonia aquifolia*) and up to 1.8284 mcg/g (the third site–*Juglans mandshurica*).

Qualitative characteristics of woody plants depression with heavy metals by their appearance is insufficient, due to their evolutionarily developed mechanisms to adapt to adverse environmental conditions. Green belts play an important role in the localization of heavy metals. For example, planting of continuous band of hawthorn and field maple along highways reduce the lead content in the zone of freeways by 30-50 %.

Some conclusionscan be made based on the above factual materials on survey of laminasplanted for the accumulation of toxins growing in Astana on three sites.

Astana is not an industrial center, and that proportion of air pollution, which at the moment is quite critical and reflected on the air, soil, and all living organismsis a consequence of power plants and auto vehicles.

Most contaminated plants were on the third site. *Juglans mandshurica* laminas have maximum lead and cadmium accumulation, and *Mahonia aquifolia* have at least 50%.

Thus, ambiguously conclusions shall be made based on above: Woody plants accumulate heavy metals in their bodies differently. When equalizing growing conditions, species with less ability to accumulate toxins are identified, but nevertheless the stability of tested plants to fairly polluted conditions of Astanacanbe reasonable mentioned. The following conclusionscan be made based on performed studies:

Analysis of the current range of Astana woody plants and forest nursery JSC “Astana Zelenstroy” indicates lack of species diversity. The identified lack admits introduction events in Astana. Based on the study of biological characteristics of woody and shrubby plants,an assortment of 50 woody species can be used in landscaping Astana was formed.

Test landings of 13 of 50 species of woody plant introductions were conducted in Astana. Plants imported from the JSC “Forest Nursery”of Almaty region located 53 km east of Almaty. Pilot group of plantswas planted on three experimental sites: *Caragana arborescens (f. pendula); Prunus divaricate; Amorpha fruticosa; Phellodendron amurense;Gleditsia triacanthos; Salix babilonica; Acer ginnala; Mahonia aquifolia; Juglans mandshurica; Populus simonii; Forsythia x intermedia Zabel; Padus avium; Fraxinus excelsior L.*

The separation of plants for three sites will allow for further full comparative observations of introduced plants growth and development.

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Т.С. Абжанов, Б.А. Кентбаева

ЭКОЛОГО-БИОЛОГИЧЕСКИЕ ОСОБЕННОСТИ НАКОПЛЕНИЯ ТЯЖЕЛЫХ МЕТАЛЛОВ В ЛИСТОВЫХ ПЛАСТИНКАХ ДРЕВЕСНЫХ РАСТЕНИЙ Г.АСТАНЫ

Анализ современного ассортимента древесных растений г.Астаны и лесного питомника АО «Астана Зеленстрой» свидетельствует о недостаточности видового разнообразия. Разделение растений по трем участкам позволит в дальнейшем провести полноценные сравнительные наблюдения за ростом и развитием интродуцентов.

Ключевые слова: тяжелые металлы, "кислотные дожди", санитарные нормы и правила.

Т.С. Абжанов, Б.А. Кентбаева

АСТАНА ҚАЛАСЫНЫҢ СҮРЕКТІ ӨСІМДІКТЕРІНІҢ ЖАПЫРАҚ ПЛАСТИНАЛАРЫНДА АУЫР МЕТАЛДАРДЫҢ ЖИНАҚТАЛУЫНЫҢ ЭКОЛОГИЯЛЫҚ-БИОЛОГИЯЛЫҚ ЕРЕКШЕЛІКТЕРІ

Астана қаласы «Жасыл құрылыс» АҚ орман тұқым бағында ағаш өсімдіктерінің қазіргі ассортиментін талдау барысында алуан түрліліктің жетіспеушілігі анықталынады. Өсімдіктерді 3 телімге бөлу арқылы интродуценттердің өсуі мен дамуын салыстырмалы бақылауға болашақта мүмкіндік береді.

Кілт сөздер: ауыр металдар, қышқылды жауын-шашын, санитарлық мөлшер және ережелер.

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Sh.A. Alpeisov, M.Zh. Nurpeissov

Kazakh national agrarian university

SCANNING ELECTRON MICROSCOPY IN STUDIES OF BIOLOGICAL SAMPLES

Abstract. This article reviews methods of biological sample preparation including plant cell for scanning electron microscopy. The methods described below for SEM have proved satisfactory with a variety of different specimens and should with minor modification be suitable for most situations.

Keywords: scanning electron microscopy (SEM), transmission electron microscopy (TEM), biological sample preparation, plant cell, specimen and materials.

Introduction

The Kazakh-Japan Innovation Centre at the Kazakh National Agrarian University has installed a combination of light and electron microscopy devices to help researchers better understand the structure, function and capabilities of the plant, animal and microorganisms cell.

The centre's Laboratory of Electron microscopy, established as part of the The Kazakh-Japan Innovation Centre, will complete assignments for KazNAU scientists and outside research groups as well as attempt to further the development of microscopic imaging. Three-dimensional mappings of cell internal structure as well as microscopic cell and tissue observation in living organisms are both capabilities of the laboratory.