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Fractional composition of compounds of zinc and lead in light chestnut soils

Abstract: The objective of this work was study and assessment of the main regularities of distribution of forms of finding of Zn, Pb in light chestnut soils of the territory of the island “Polkovnichii” (Semey, Kazakhstan) as a basis of assessment of influence of technogenic pollution and development for successful monitoring of a surrounding medium, protection of soils. It was found that average total of Pb content of 1.2 times, of Zn content – 2.4 times lower than their clark contents in soils. The examined soils on the level of the average content of mobile forms of zinc are the medium soils by the presence of this element. Reliable direct correlative dependence on a humus and pH for acid soluble (extracting agent – 2.5% of CH₃COOH) form of lead is revealed. Reliable positive correlative dependence on values pH the forms of Zn strongly bound to organic matter of the soil is found. It was revealed that the migration of forms of finding of lead and zincum on a profile of the soil happens nonuniformly: accumulation of zinc is noted in the top horizons of the soil – humic A_n and the humic accumulative horizon of A₁. It was found that accumulation of lead happens in the illuvial horizon of B₁ of the investigated soils.

Key words: zinc, lead, total content, mobile forms, migration, light chestnut soils

Introduction

An information about the content of toxic ingredients in the soil of a particular region take a very important place at solving majority practical environmental problems of anthropogenic pollution [1-6]. At pollution level assessment as background usually take uncontaminated territories with a similar soil cover for which concentration of heavy metals is known [7, 8]. In this case it is very difficult to observe the principle of analogy because the urban soils – urbanozems strictly speaking under natural conditions have no analogues. In this connection there is an urgent task of finding the local urbanized background that could be used to assess the level of soil contamination.

The aim of this research was study and assessment of the main regularities of distribution of forms of finding of Zn, Pb in light chestnut soils of the territory of the island “Polkovnichii” (Semey, Kazakhstan) as a basis of assessment of influence of technogenic pollution and development for successful monitoring of a surrounding medium, protection of soils.

Experimental

The natural light chestnut soils typical of “Polkovnichii” island were chosen for investigation. The re-

searched territory is located within the city of Semey of the East Kazakhstan region of the Republic of Kazakhstan. The city of Semey is divided by the Irtysh River on left-bank and right-bank. In the middle of the Irtysh River there is an island “Polkovnichii” (fig.)

The samples of all of the genetic horizons of the soil profile were taken for investigations. Determination of macrocomposition of all tests of soils (pH, a humus, CO₂ of carbonates, granulometric composition) was carried out by standard methods [9]. Among the heavy metals as studying objects lead and zinc have been taken. The choice of these elements is explained two reasons: the first – the physiological importance of zinc in living organisms and in particular for plants, and the second – the lack of information on the biogeochemistry of these elements on the island “Polkovnichii” needed to solve a number of scientific and practical issues [1-3, 7]. The content of heavy metals in the explored soils was determined on the KFK-3 device by a photocolometric dithizone method by G.Ya.Rin’kis’s recipe [9-11]. The reproducibility of the method was equal to ± 4.2%. Selection of fractions of Pb and Zn was carried out by method of parallel extraction. All analytical data were processed by mathematical analysis and mathematical statistics in soil science according to E.A.Dmitriev [12].



Figure – An island "Polkovnichii", Semey 070000, Kazakhstan

Results and discussions

The obtained results showed (Table) that the average total content of lead in the general set of soil sam-

ples of the investigated territory in 1.2 time, of zinc – is 2.4 times lower than their clark contents in soils.

In magnitude of the average total content the studied heavy metals are arranged in such a way: Zn>Pb. On value of coefficient of a variation (in %) heavy metals in the researched soils are located in the following decreasing order: Pb (34)>Zn (17).

The content of total forms of heavy metals on a profile of soils is distributed unevenly. The maximal content of lead is characteristic of the illuvial horizon of B₁, minimum – of the humic horizon A. The maximal content of a total form of Zn is characteristic of the humic horizon of A_n and the humic and accumulative horizon of A₁, minimum – of the transitional horizon of BC. The increased content of a total form of Zn in the humic and humic and accumulative horizons is explained by the increased contents in them of the maximum quantity of a humus, and also higher value pH. In turn, the increased content of a total form of lead in the illuvial horizon B₁ is explained by the increased contents in this horizon of the maximum quantity of physical clay (<0.01 mm), possible carbonaceous and alkaline geochemical barriers.

Table – The lead and zinc total content of in the light chestnut soils of "Polkovnichii" island (in mg/ kg)

Metal	K _v	M±m	V, %	Clark in a soil [8]	Clark in the lithosphere [8]	Maximum concentration limit in the soil [4]
Pb	4.91 – 12.24	8.32 ± 1.05	34.0	10.00	16.0	100
Zn	14.84-23.67	20.86± 1.37	17.0	50.00	83.0	300

Note: K_v – a range of a variation, M±m – an arithmetic average and its mistake, V – variation coefficient.

As it was shown in numerous researches, an organic matter and its components form various complex compounds with heavy metals [1, 7], and the fine-grained mineral phase is the strong adsorbent of heavy metals [6]. Results of the carried out researches show that with increase in content of physical clay in the soil the content of a bulk form of lead increases, and also with increase in content of a humus in the soil the tendency to increase in content of a bulk form of Zn takes place. Reaction of aqueous soil slurries in the humic and humic and accumulative horizons is neutral, in particular, at values pH, the close to neutral, the maximum of absorption of heavy metals by organic matter and clay minerals is reached [6, 13].

Amplitude of fluctuation of content of elements in the soil is a little various: for lead accumulation in the top horizon of the soil sharply increases with

a depth, on the contrary, accumulation in the humic and accumulative horizon which gradually decreases is characteristic of Zn. It indicates that lead in the researched soils is less mobile metal, is capable to form steady compounds with finely dispersed mineral phase of the soil. It should be noted that zinc in these investigated soils relates to metals less mobile in the soil; a key role in this belongs to an organic substance capable of forming stable complexes with zinc, which is very important and has great practical significance for the management of migration and bioavailability of this element in the soil. The research of the work showed that the observed the unequal correlation between the total content of heavy metals and indicators of humus, soil pH and physical clay. A positive reliable correlative dependence of content of a total form of lead only on availability of physical clay is revealed. In the investigated light chestnut

sandy loam soils reliable positive correlative dependence between the total content of Zn and existence of a humus, and also value pH is found. The established level of total contents in soils of the studied urbanized background is much lower than the recommended maximum permissible limits. V.V. Kovalsky established the threshold concentrations of some elements in soils according to their possible pathological influences on farm animals [14]. When compared with these threshold concentrations total zinc content is within the lower threshold boundary. The investigated light chestnut soils of “Polkovnichii” island are characterized by low total zinc content in comparison with soils of different regions [10, 11, 13, 14]. According to gradation to Ya.V. Peyv and G.Ya. Rin’kis [9], by the level of average content of the mobile form of Zn the researched soils belong to the medium soils accordingly presence of this element.

Data on the background content of zinc and lead in the studied soils are very valuable, give the possibility of systematic observations in this natural region and improve the objectivity of the evaluation of the emerging environmental conditions. In recent years farmers to the soil introduce Zn-containing fertilizers therefore carrying out a research of influence of physical and chemical properties of soils of the region on effectiveness of zinc fertilizers has applied value. Thus, as a result of the research it was found that the studied soils are characterized by deficiency of zinc content and by the level of the average content of mobile forms of zinc belong to the medium soils by the presence of this element. This must be considered when using zinc-containing fertilizers into the soil. It is necessary to carry out detailed investigation of the influence of physical and chemical properties of the soil in the region on the effectiveness of zinc fertilizers, and to continue research in this direction.

Conclusions

So, the soils of the island “Polkovnichii” (Kazakhstan) were studied. It was found that the total content of lead fluctuated from 4.91 to 12.24 mg/kg, the average value was equal to 8.32 mg/kg, the coefficient of a variation was equal to 34.0%; the total content of zinc was in limits of 14.84-23.67 mg/kg, the average value was equal to 20.86 mg/kg, the coefficient of a variation was twice less, than for lead and amounts 17%. It was revealed that the average total content of lead in 1.2 times, zinc – 2.4 times lower than their clark contents in soils. The total content of zinc in the soils of the examined area is located within the lower threshold limits. Migration of forms

of finding of lead and zincum on a profile of the soil happens nonuniformly: accumulation of zinc is noted in the top horizons of the soil – humic A_n and the humic accumulative horizon of A_1 . It indicates the leading role of soil organic matter in accumulation of this element. Lead accumulation occurs in the illuvial horizon B_1 of the investigated soils, due to the increased content of physical clay in this horizon.

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