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ACCUMULATION OF HEAVY METALS IN TYPICAL IRRIGATED GRAY SOIL LAYERS OF THE TASHKENT REGION AND IN THE ORGANS OF FRUIT TREES GROWN ON THESE SOILS

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Abstract: *The article examines the accumulation of heavy metals in typical irrigated gray soils of the Piskent district of the Tashkent region and in the organs of fruit trees grown on these soils. It was found that the organs of fruit trees contain high concentrations of Zn, Pb, Cr, Cd elements.*

The content of mobile heavy metals in typical gray soils has the following decreasing order: Zn→Pb→Cu→Cd→Ni→Cr→Co.

Key words: *Soil, heavy metal, pollution, accumulation, peach, apple, leaf, fruit, seed, twig.*

INTRODUCTION. Heavy metals are mobile, moving through the soil profile and changing into a form more readily available for plant uptake [8; 1276-1280-p.], [10; 63-72-p.]

Soils located close to industrialized areas survive and develop under the influence of natural soil-forming factors (climate, relief, parent rocks, soil flora and fauna, time), but technogenic factors affecting the soil lead to a deterioration of soil ecology [5; 27-32-p.], [6; 78-80-p.], [13; 36-44-p.], [4; 142-147-p.].

The chemical composition of plants is closely related to the elemental composition of the soil. Therefore, excessive accumulation of heavy metals in plants is primarily associated with their high concentration in the soil. Plants absorb mobile forms of heavy metals during their development, their amount being closely related to

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the presence of organic matter and the buffering capacity of the soil [7; 49-p.]. The accumulation of heavy metals in fruit trees in different concentrations depends on the ability of plant species to absorb elements and their differential accumulation in different organs [3; 306-310-p., 1; 157-168-p.].

Heavy metals accumulate in the surface layer of the soil without undergoing physicochemical or biological degradation, causing changes in soil properties, and over a long period of time accumulate in a mobile form that is absorbed by plant roots [12; 224-226-p.].

Many scientists have noted that the accumulation of heavy metals in plants varies depending on the tree species in nature. It has been found that the specificity of heavy metal accumulation to a tree species can be very clearly demonstrated in experiments. Because it has been found that the accumulation of heavy metals in some plant species is hundreds and thousands of times higher than the permissible limits [11; 131-p.], [2; 246–254-p.].

V.B.Ilyin found that some types of heavy metals (Fe, Cu, Zn, Mn, Mo) are necessary for plant metabolism in small concentrations, and if their amount exceeds a certain level, they become toxic, while some heavy metals (Pb, Cd, Hg) are considered metals that do not participate in plant metabolism, and they have a toxic effect on plants even at very low concentrations. [9; 150-151- p.].

MATERIALS AND METHODS. The research was conducted on typical gray soils and apple and peach tree stands in the Piskent district of Tashkent region. Determination of the amount of heavy metals in soil and plant samples was studied by the atomic absorption method in the laboratory equipment “Optical emission spectrometer AVIO-200” based on the method “Методические указания по определению тяжелых металлов в почвах сельхозугодий и продукции растениеводства” (1992).

RESULTS AND DISCUSSION. The amount of mobile copper (Cu) in typical irrigated loamy soils in the Piskent district of the Tashkent region was found to be 16.37-13.79-15.79 mg/kg (sections 50-51-52) in the 0-30 cm layer, or 5.46-4.60-5.26 times higher than maximum allowable concentration (MPC), while in the 30-50 cm

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layer it was found to be 12.19-12.52-11.02 mg/kg, in the 50-80 cm layer it was found to be 8.24-9.33-8.26 mg/kg, and in the 80-100 cm layer it was found to be 3.33-2.37-4.11 mg/kg. The amount of mobile copper in all soil layers was found to be above the permissible limit. It was observed that the amount of copper in the soil in a mobile form decreases from the arable layer of the soil (0-30 cm) to the lower layers.

The amount of zinc in mobile form is 167.13-154.80-133.46 mg/kg in the 0-30 cm layer of the soil, 131.63-119.41-129.41 mg/kg in the 30-50 cm layer, 80.26-76.17-69.67 mg/kg in the 50-80 cm layer, In the 80-100 cm layer, it is 41.37-32.36-29.25 mg/kg, and it was found that the amount of zinc in all studied soil layers is 1.27-7.27 times higher than maximum permissible concentration (MPC).

It was found that the amount of elements of chromium, nickel, cobalt in irrigated typical gray soils is below the maximum allowable concentration (MPC).

The accumulation of the chromium element in soil layers has been determined in the following concentrations: 3.56–4.00–4.69 mg/kg in the 0–30 cm layer; 2.42–2.46–2.71 mg/kg in the 30–50 cm layer; 1.87–1.93–1.97 mg/kg in the 50–80 cm layer; and 1.20–1.29–1.54 mg/kg in the 80–100 cm layer.

Pb was found to be 40.60-41.40-36.06 mg/kg or 6.77-6.90-6.01 times higher than the MPC in the 0-30 cm layer of soil, 28.64-29.49-30.26 mg/kg or 4.77-4.92-5.04 times higher than the MPC in the 30-50 cm layer, 15.33-13.66-18.85 mg/kg or 2.55-2.28-3.14 times higher than the MPC in the 50-80 cm layer, and 8.24-5.25-6.25 mg/kg or 1.37-1.04 times higher than the MPC in the 80-100 cm layer.

Cadmium was found to accumulate in the 0-30 cm layer of soil at levels of 1.51-1.99-2.04 mg/kg, or 3.02-3.97-4.07 times higher than the MPC, in the 30-50 cm layer at levels of 0.91-1.28-1.18 mg/kg, in the 50-80 cm layer at levels of 0.59-0.84-0.87 mg/kg, and in the 80-100 cm layer at levels of 0.62-0.43 mg/kg (Table 1).

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Table 1

Accumulation of heavy metals in mobile form in typical irrigated gray soil layers in Piskent district of Tashkent region, mg/kg

Section number	Soil layer, cm	Cu		Zn		Cr		Co		Ni		Pb		Cd	
		quantity	the difference of MPC	quantity	the difference of MPC	quantity	the difference of MPC	quantity	the difference of MPC	quantity	the difference of MPC	quantity	the difference of MPC	quantity	the difference of MPC
Piskent district "Khidirov Olimjon" farm (2021 year)															
50-кесма	0-30	16,37	5,46	167,13	7,27	4,69	0,78	2,14	0,43	4,23	1,06	40,60	6,77	1,51	3,02
	30-50	12,19	4,06	131,63	5,72	2,46	0,41	1,92	0,38	2,91	0,73	28,64	4,77	0,91	1,81
	50-80	8,24	2,75	80,26	3,49	1,93	0,32	1,66	0,33	2,36	0,59	15,33	2,55	0,59	1,18
	80-100	3,33	1,11	41,37	1,80	1,54	0,26	1,64	0,33	1,69	0,42	8,24	1,37	0,62	1,24
Piskent District "Piskent Erkin boglari" farm (2021 year)															
51-кесма	0-30	13,79	4,60	154,80	6,73	4,00	0,67	2,10	0,42	3,97	0,99	41,40	6,90	1,99	3,97
	30-50	12,52	4,17	119,41	5,19	2,42	0,40	1,93	0,39	3,20	0,80	29,49	4,92	1,28	2,56
	50-80	9,33	3,11	76,17	3,31	1,82	0,30	1,66	0,33	2,78	0,69	13,66	2,28	0,84	1,67
	80-100	2,37	0,79	32,36	1,41	1,29	0,21	1,52	0,30	1,35	0,34	5,25	0,88	0,43	0,86
52-кесма	0-30	15,79	5,26	133,46	5,80	3,56	0,59	2,39	0,48	3,52	0,88	36,06	6,01	2,04	4,07
	30-50	11,02	3,67	129,41	5,63	2,71	0,45	2,08	0,42	2,95	0,74	30,26	5,04	1,18	2,37
	50-80	8,26	2,75	69,67	3,03	1,97	0,33	1,69	0,34	1,58	0,39	18,85	3,14	0,87	1,73
	80-100	4,11	1,37	29,25	1,27	1,20	0,20	1,42	0,28	1,24	0,31	6,25	1,04	0,62	1,25
MPC		*3*		*23*		*6*		*5*		*4*		*6*		*0,5*	

Note: maximum allowable concentration (MPC)

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In the Qirqqizobod village of the Piskent district, Tashkent region, it has been determined that in irrigated typical sierozem soils, the accumulation levels of zinc, lead, copper, and cadmium exceed the permissible limits by up to 8 times.

The accumulation of heavy metals in the organs of fruit trees grown on typical gray soils contaminated with mobile Pb, Cd, Zn, and Cu elements up to 8 times higher than the permissible limit was found to be as follows.

The copper element was found to accumulate in peach leaves at 14.82 mg/kg (the highest) 1.48 times higher than the REM, in twig at 11.79 mg/kg, in seeds at 1.97 mg/kg, and in fruits at 4.41 mg/kg. Copper accumulation in the generative and vegetative organs of apple varieties Starkrimson, Renet Simirenko, and Kandilsinap was found to be below the MPC.

The concentration of the element Ruh in peach leaves was found to be 94.19 mg/kg or 9.42 times higher than the MPC, in twig 67.77 mg/kg or 6.78 times higher than the MPC, in kernels 27.25 mg/kg or 2.72 times higher than the MPC, and in fruits 21.37 mg/kg or 2.14 times higher than the MPC. In the leaves of the apple varieties Starkrimson, Renet Simirenko, and Kandilsinap, the concentration was found to be 42.59-29.04-43.28 mg/kg or 4.26-2.90-4.33 times higher than the MPC, and in fruits and seeds, the concentration was found to be lower than the MPC.

The bioaccumulation of chromium in peach leaves was found to be 0.82 mg/kg or 8.18 times the MPC, in twig 0.50 mg/kg or 4.98 times the MPC, in kernels 0.41 mg/kg or 4.09 times the MPC, and in fruits 0.26 mg/kg or 2.63 times the MPC. It was found that the amount of chromium in the leaves and twig of all fruit trees in this region was up to 8 times the MPC, and in seeds up to 2 times the MPC.

The bioaccumulation of lead in peach leaves was found to be 13.29 mg/kg or 33.23 times the MPC, in twig 8.99 mg/kg or 22.49 times the MPC, in kernels 3.47 mg/kg or 8.68 times the MPC, and in fruits 1.87 mg/kg or 4.68 times the MPC. Among all the fruit trees studied, only peach fruit was found to have a lead content several times higher than the MPC.

The accumulation of copper in peach organs was found to be as follows: 14.82 mg/kg in the leaves, which is 1.48 times higher than the MPC; 11.79 mg/kg in the twig,

or 1.18 times higher than the MPC; 1.97 mg/kg in the kernels; and 4.41 mg/kg in the fruit, indicating concentrations below the MPC (Table 2).

Table 2

Accumulation of heavy metals in fruit trees grown on typical gray soils polluted with heavy metals due to the influence of industrial enterprises in the Piskent district of the Tashkent region, calculated as dry matter

№	Fruit type and variety	organs of trees	Cu		Zn		Cr		Co		Ni		Pb		Cd	
			Quantity ± error, mg/kg	the difference of MPC	Quantity ± error, mg/kg	the difference of MPC	Quantity ± error, mg/kg	the difference of MPC	Quantity ± error, mg/kg	the difference of MPC	Quantity ± error, mg/kg	the difference of MPC	Quantity ± error, mg/kg	the difference of MPC	Quantity ± error, mg/kg	the difference of MPC
2021-2023 year																
1	Starkrimson apple variety	fruit	1,63±0,26	0,16	1,61±0,77	0,16	0,15±0,02	**1,48**	0,05±0,01	0,05	0,17±0,05	0,34	0,18±0,03	0,45	0,05±0,01	**1,70**
		seed	0,59±0,16	0,06	11,56±3,52	1,16	0,22±0,03	2,23	0,07±0,01	0,07	0,14±0,01	0,28	0,33±0,15	0,83	0,09±0,02	2,94
		leaf	8,46±1,21	0,85	42,59±4,62	4,26	0,38±0,05	3,80	0,10±0,04	0,10	0,71±0,15	1,42	5,93±1,02	14,83	0,22±0,04	7,37
		twig	4,56±1,00	0,46	38,11±4,86	3,81	0,30±0,04	3,04	0,07±0,02	0,07	0,16±0,02	0,33	4,94±0,62	12,34	0,14±0,02	4,73
2	Renet Simirenko apple variety	fruit	1,67±0,46	0,17	5,66±1,30	0,57	0,17±0,02	**1,67**	0,05±0,01	0,05	0,33±0,05	0,66	0,37±0,01	0,92	0,07±0,01	**2,20**
		seed	2,01±0,68	0,20	9,86±2,48	0,99	0,24±0,03	2,44	0,11±0,04	0,11	0,21±0,03	0,42	0,44±0,04	1,10	0,07±0,01	2,31
		leaf	7,72±2,08	0,77	29,04±2,91	2,90	0,51±0,07	5,06	0,25±0,07	0,25	0,67±0,06	1,33	5,48±0,58	13,69	0,21±0,05	7,08
		twig	3,60±1,62	0,36	25,36±3,87	2,54	0,25±0,04	2,52	0,08±0,05	0,08	0,37±0,07	0,75	3,82±0,79	9,55	0,18±0,04	6,14
3	Kandilsinap apple variety	fruit	1,10±0,23	0,11	4,25±0,91	0,42	0,19±0,03	**1,85**	0,04±0,02	0,04	0,18±0,03	0,36	0,33±0,04	0,84	0,05±0,01	**1,66**
		seed	0,93±0,41	0,09	8,83±0,99	0,88	0,18±0,03	1,83	0,07±0,01	0,07	0,24±0,04	0,48	0,43±0,09	1,08	0,12±0,03	3,86
		leaf	7,90±0,83	0,79	43,28±3,48	4,33	0,48±0,07	4,79	0,16±0,04	0,16	0,78±0,12	1,57	6,16±0,77	15,39	0,20±0,04	6,75
		twig	2,54±0,82	0,25	26,07±2,03	2,61	0,41±0,06	4,08	0,08±0,03	0,08	0,49±0,07	0,98	2,88±0,69	7,20	0,12±0,02	3,95
4	Peaches Champion variety	fruit	4,41±1,49	0,44	21,37±3,63	**2,14**	0,26±0,04	**2,63**	0,16±0,06	0,16	0,40±0,06	0,79	1,87±0,35	**4,68**	0,01±0,01	0,50
		leaf	14,82±2,52	1,48	94,19±11,26	9,42	0,82±0,11	8,18	0,36±0,05	0,36	0,61±0,06	1,21	13,29±1,17	33,23	0,03±0,00	1,07
		twig	11,79±1,74	1,18	67,77±6,09	6,78	0,50±0,07	4,98	0,29±0,04	0,29	0,54±0,06	1,08	8,99±1,69	22,49	0,03±0,01	1,09
		seed	1,97±1,09	0,20	27,25±5,82	2,72	0,41±0,06	4,09	0,08±0,01	0,08	0,07±0,02	0,14	3,47±0,60	8,68	0,01±0,01	0,46
MPC			***10***		***10***		***0,1***		***1***		***0,5***		***0,4***		***0,03***	

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Conclusion. Emissions from technogenic facilities lead to the accumulation of pollutants in the topsoil (0–30 cm layer) of nearby areas through atmospheric deposition. As a result, concentrations of heavy metals in the soil reach the following levels: Cu – 13.79–16.37 mg/kg, Zn – 133.45–167.13 mg/kg, Pb – 36.06–41.40 mg/kg, and Cd – 1.51–2.04 mg/kg. These values are 3.02 to 7.27 times higher than the regionally established maximum permissible concentrations (MPC).

An increase in the concentration of heavy metals in soil leads to a higher accumulation of these metals in the organs of fruit trees grown in such soils.

The accumulation of heavy metals in the organs of fruit trees varies depending on the tree species and soil-climatic conditions; however, in almost all fruit trees, the following increasing sequence is typically observed: fruit→seed→twig→leaf.

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