ABSTRACT

to the dissertation on the "Study of heavy metals' migration and transformation in the "soil-plant" system when growing vegetables in the Turkestan region" theme which has been written by Zhangeldi Nurumbetovich Kurganbekov submitted for the degree of PhD in philosophy in 6D060800 – "Ecology" specialty.

The accumulating and migration properties of heavy metals in the "soil-plant" system in agricultural fields of Southern Kazakhstan were studied.

The aim is to study the processes of heavy metals' accumulation and distribution in agricultural plants grown near highways of the Turkestan region and industrial facilities, as well as to determine environmental indicators of agricultural products' quality.

The theme relevance is to constantly monitor the heavy metals distribution in the soil layer and plants scientifically, study the patterns of their distribution in the "soil-plant" system, environmental monitoring of agricultural products' purity of the Turkestan region, and also make recommendations to reduce heavy metal concentrations below a possible limit.

The scientific novelty is that the possibilities of heavy metals' accumulation and distribution in the "soil-plant" system in agricultural fields along the Shymkent-Saryagash-Maktaral highway in the Turkestan region of Southern Kazakhstan (fields, gardens, agricultural facilities gradually separated from the road) were investigated; the wild plants' ability to accumulate heavy metals in the fields of Akdalinsk, Dermeninsk rural districts and the surroundings of Arys city, a large railway junction in Arys district were determined; the characteristics of heavy metals' migration in the soil of the Zhartytobe village, the surroundings of Sholakkorgan regional center and Taukent city of Sozak district, which has particular climatic conditions and constant wind were studied.

Heavy metals qualitative and quantitative indicators were determined depending on the time of year and climate change. 20 garden plots located in the Maktaral region, the birthplace of vegetables and fruits that receive a lot of solar energy, were studied and the peculiarities of the plants ability belonging to different families to accumulate heavy metals were identified.. Hazardous areas were identified by calculating the heavy metals' bioaccumulation from soil to plants (bioaccumulation factor) by mapping soil contamination with heavy metals from the Turkestan region. Ashchisai, Kentau, Phosphorus Plants were found as a moderately polluted area, and Baijansai lead plant as a highly polluted.

A mathematical model was determined to describe the process of heavy metals' accumulation in soil and crops.

Research methods were carried out by studying the common heavy metals' accumulation and migration in the "Soil plant" system in agricultural fields of the Turkestan region, and the possibilities of preventing soil infertility by determining the causes of soil degradation were analyzed. The amount of heavy metals in crops and seeds was determined by biotesting. The influence of different fertilizers on

the heavy metals' assimilation by plants was evaluated in the laboratory. The dynamics of dry mass accumulation and agricultural products' productivity depending on the heavy metals amount in the soil under agricultural conditions was determined and analyzed. The properties' comparative analysis of heavy metals' accumulation in soil and crops was carried out depending on regional characteristics. An environmental cartography was created that describes the environmental quality of regional agricultural products. Changes in the soil cover of environmentally problematic areas, soil changes in climatic conditions and time periods, studying the properties of plant resistance to heavy metals and climatic conditions were analyzed.

Safe zones of agricultural fields along the Shymkent-Saryagash-Maktaral highway were determined for the first time according to the distances level, and levels of heavy metal pollution and sowing limits were also indicated based on **scientific research's results**. The levels of heavy metals' accumulation and migration, determined by the relief and climatic conditions of the Arys and Sozak regions were determined, and the possibilities of getting rid of them due to the ability of local wild plants to absorb heavy metals were analyzed. The role of heavy metals in soil and plants in laboratory and agricultural conditions, the importance of using mineral and organic fertilizers to obtain environmentally friendly products through biotesting of heavy metals in plant crops and seeds was established and discussed. Dangerous zones were determined by calculating the bioaccumulation of heavy metals from soil into plants (bioaccumulation coefficient) by creating a cartogram of soil contamination with heavy metals in the Turkestan region. It has been established that the Ashchysay, Kentau, Phosphorus plants belong to a moderately polluted zone, and the Lead Plant and Baizhansai belong to a highly polluted zone. The coefficient of heavy metals' biological accumulation in plants, triangulated in Matlab, was analyzed by regression method.

Scientific results and conclusions: ecological mapping of soils and vegetable plants along the Shymkent-Saryagash-Abay highway, the territories of the Arys and Sozak districts was compiled, where samples were taken to determine the properties of heavy metals' accumulation and migration in the "soil-plant" system; proposed as an object of study Analyzes of soil and plant samples were obtained: wild plants were analyzed by atomic adsorption, agricultural plants (vegetables and fruits) by inductively coupled plasma mass spectrometry (ICP-MS). All types of economic analyzes are carried out in the accredited Engineering Regional Testing Laboratory (ERLIP).

In the laboratory of the "Ecology" department: analysis of soil samples was carried out using the following methods: active forms of phosphorus and potassium - according to the Machigin method modified by Central research institute of agrochemical services of agriculture (MEMST 26205-84);

- - determination of organic substances - according to the Tyurin method as modified by Central research institute of agrochemical services of agriculture (MEMCT 26213-91);

- Basis of Ca^{+2} and Mg^{+2} exchange in cation exchange vessels (EKG) - according to Shaimukhamedov's method;

- determination of the physical clay and clays proportion - according to the Kachynski method;

- pH of the water pump - using the potentiometric method (MEMST 26423-85);

- the amount of carbonates in the soil - according to the Scheibler method;

- nitrite nitrogen - by ionometric method (MEMST 26951-86).

Cucumber, tomato and sweet pepper (pepper) seeds, germination of plant seeds in laboratory conditions, and growth energy of saline solutions were used as test objects for plant viability in order to study the effect of heavy metals $CuSO_4$, CdC_{l2} and $ZnSO_4$ at a concentration of $10^{–3}$–$10^{–5}$ mol/l, the length of the plant stem and root, above-ground and underground accumulation of biomass showed an inverse relationship with a decrease in the concentration of heavy metals

On the 7th day of growing (roots and sprouts) seedlings of vegetable crops (tomatoes, cucumbers, sweet peppers), it was found that viability results increase with a decrease in the concentration of heavy metals. The growth of pepper shoots and roots is accelerated at concentration $ZnSO_4$ and CdC_{l2} 10^{-5}, and tomato shoots - at a concentration CdC^{l2} 10^{-5}.

An important indicator characterizing the plants' growth and their organs is the accumulation of biomass in the roots and stems. In tomato, the concentration of $ZnSO_4$ and CdC_{l2} varies from $10^{–3}$ roots to -$10^{–5}$ stems, $CuSO_4$ accumulates in the stems. The accumulation of pepper biomass is $CuSO^4$ $10^{–3}$, $^{-4}$ in the stem, -$10^{–5}$, $ZnSO_4$ -$10^{–3}$, $^{-4}$ in an equal state, -$10^{–5}$ moves into the stem, CdC_{l2} $10^{–3}$-$10^{–5}$ moves from the root to the stem, the cucumber has $10^{–3}$–$10^{–5}$ moves from the stem to the root.

Our studies with selected crops in 20 garden plots located in the Maktaral region showed that plants belonging to different families differ in their ability to accumulate heavy metals. According to the ability of fruits and vegetables to absorb heavy metals, among the elements that accumulate in the body relatively more: in melons, peaches, watermelons, apples - Zn and Cu; Strawberry – Cu, Ni; For grapes – Pb, Cu. MPC> Zn, Cd, MPC< Su in watermelon, Co - in peach, Ni - in strawberries, Pb - in grapes, strawberries and apples. Vegetables and fruit trees (surface) well absorb the concentration of Zn and Cu heavy metals. Their active order by Zn is cucumber > tomato > broccoli > cabbage. And according to C, cucumber > green pepper > tomato > broccoli > cabbage. Concentrations of other heavy metals are similar to the MPC. Vegetables and fruits absorb Zn and Cu well. Pb – in beets and potatoes, Co – in potatoes, Ni – in onions, potatoes, beets.

Study accumulation and distribution patterns of heavy metals along highways. Vegetation and soil samples were studied at a distance of 20, 50, 100, 500 meters in a layer of 0-20 cm. Depending on the level of anthropogenic load, there is no clear pattern in the change in the coefficient of biological accumulation of heavy metals in plants and the coefficient of accumulation in soil. Adsorbed compounds from the atmosphere can play an important role in the accumulation of heavy metals in the above-ground parts of plants

As a result of experiments on the effect of the heavy metal salts concentration on soil microorganisms, a tendency to a decrease in the number of

bacteria was revealed depending on the concentration added to the soil. A high concentration of heavy metal salts (10^{-3}) suppresses microflora in the soil; low concentrations did not affect the microflora and did not have a stimulating effect.

According to the laboratory experiments' results, the introduction of phosphorus fertilizers into the soil had a significant effect on the growth and development of the parsley plant. Despite the significant background content of the macroelement in mobile form, parsley was very sensitive to an increase in the concentration of phosphorus in the soil. Plant weight increased in proportion to the dose of phosphorus fertilizers

The influence of the manure amount (livestock, cattle, poultry) on the content of heavy metals in cucumber tubers and growing cucumber stems, mg/kg (2019-2020). After entering (three times) as the amount of manure increases, Zn is not observed in the manure of small animals, Pb is not observed in all manure.

When determining the dynamics of dry mass accumulation and potato yield depending on the heavy metals amount in the soil under field conditions, it was found that lead-contaminated soil does not affect potato nodules. The amount of Zn increased under the influence of lead. The amount of Pb in root vegetables increased under the influence of zinc. Root crops obtained even with moderate Zn contamination comply with MPC.

Lime had the following effect on the heavy metals amount in potato tubers and peels: the Zn content in tubers decreased by 18%, but did not change in the peel; the amount of lead in tubers increased by 13%, and in the stem decreased by 25%; the amount of copper remained the same as in the trace-free version. During the experiment, heavy metals did not accumulate in the amount of heavy metals to which indicator was not added.

By calculating bioaccumulation (bioaccumulation coefficient) as the ratio of the average amount of heavy metals in plants and tomatoes to the average amount in soil, a tomato field was selected from the Akdala, Dermene regions, surroundings of Arys city of Arys district, along the Sozak border road, Zhartytobe, Sholakkorgan, Taukent of Sozak region. Hazard levels were determined by calculating soil bioaccumulation of heavy metals relative to plants