Effect of cadmium on agrochemical and ecological status of irrigated soils

Sobirjon Nizamov, Khurshida Riskieva, Mukhammad Umarov, Jahongir Kuziev and Miraziz Mirsodikov

1 Institute of Soil Sciences and Agrochemical Research, 1, Talabalar street, Tashkent, 100095, Uzbekistan
2 Tashkent State Agrarian University, 2, University street, Tashkent, 100140, Uzbekistan

Abstract. The sources of environmental pollution with heavy metals are mainly wastes of the metal production industry, combustion products of various fuels, car fumes and exhaust gases, chemicals used in agriculture, etc. The use of coal, oil, gas and a number of other fuels is increasing day by day, which pollutes the environment several times more than the metal production industry. Also, heavy metals enter the soil with biocides and mineral fertilizers, and soil contamination with heavy metals accumulates in the human body along the food chain and causes various diseases. In Uzbekistan, serious attention is being paid to the issues of ensuring ecological stability, creating the necessary conditions for the population to have a comfortable natural environment, rational and effective use of natural resources, preventing emerging environmental problems and eliminating their negative consequences. This article presents the accumulation of cadmium element in the takyr-meadow and meadow soils of Kashkadarya region, Kasbi district, exceeding the permissible standards.

1 Introduction

Various substances in waste from industrial enterprises, mainly sulfur oxides, nitrogen oxides, carbon oxides; heavy metals - iron, lead, copper, cobalt, nickel, cadmium, mercury salts, etc., have a negative impact on the atmosphere and the world of life in general. In order to protect the environment from pollution by heavy metals, first of all, it is desirable to carefully improve the industry that produces metals [1, 2].

In the developed world, anthropogenic changes have affected almost all ecosystems of our planet [3]. In addition to industrial pollution sources, the share of agrotechnical pollutants is also growing. According to the information of the Research Institute of Soil Science and Agrochemistry (Uzbekistan), the content of the soil distributed in the main massifs where rice is grown in Kazakhstan exceeds the permissible maximum concentration of lead, nickel and copper elements [4]. For example, in the alluvial plains of the Shieli massif in the ancient deltas of the Syrdarya (Uzbekistan), it was found that lead in mobile and general form increased by 2 times, and mobile nickel by 1.5 times [5].

One of the relatively volatile heavy metals is cobalt. A small fraction of the aerosol behaves as an atmospheric gas. Low precipitation rates (mm/s) provide sufficient lifetime...
of particles for global migration in the atmosphere (from a few days to several weeks). In this case, man-made cadmium, as an intensively driven metal in relation to the vapor-gas phase of aerosols, is poorly captured by ash filters and is intensively released into the atmosphere with gaseous wastes of thermal power plants. When leaving the smoke exhaust pipes, the ejected metals condense in dusty particles of natural and man-made origin [6].

For chalcophilic heavy metals, including margium and antimony, the anthropogenic share of their total amount in the atmosphere has increased by 50%, for Pb, Cd, Zn, their share in atmospheric precipitation is 78-99%. Therefore, the concept of "background" is relative to their atmospheric precipitation [7].

The toxicity of cadmium for plants is manifested in the violation of enzyme activity, the reduction of photosynthesis, the violation of transpiration, the inhibition of the reduction of NO₂ to NO, and the difficulty in the reception and exchange of a number of nutrients in plants. External symptoms - delayed growth, damage to the root system, chlorosis of leaves. In addition, it is an antagonist of a number of nutrients in plant metabolism. It ranks first among heavy metals (cadmium > copper > zinc > lead) in terms of phytotoxicity and ability to accumulate in plants [8].

The study of all agricultural plants characteristic of the territory of Rostov region showed that the lowest average amount of cadmium was found in rye grains, the highest - in sunflower. Average cadmium content decreases in the following order: sunflower > corn > barley > wheat > rye. Long-term use of mineral fertilizers and meliorants can change the cadmium cycle. This is due to the high mobility of the element, which can increase as a result of intensive agricultural production [9].

Differences in the levels of cadmium tolerance were found depending on the types of plants. For example, beets can accumulate 22 times more cadmium than beans. It is unlikely that agricultural crops will accumulate cadmium in soil to phytotoxic levels, but there is a risk that food crops will accumulate cadmium at levels that pose a risk to human health at current levels of soil contamination. As a result of high amounts of cadmium entering the soil, it can pass through the food chain from external sources to the soil, and then to plants, animals and humans, causing negative effects on all links [10].

The purpose of the study is to determine the amount of toxic elements in irrigated soils and their impact on the soil environment, ecological and agrochemical conditions.

2 Materials and methods

As the object of the study, the light takyr meadow and meadow soils distributed in the Kasbi district of the Kashkadarya region were selected. The subject of research is irrigated soils, nutrients, heavy metals, soil ecological status.

Studies were conducted in field and laboratory conditions. Methodological guides such as "Methods for Conducting Field Experiments" were used [5-7]. The amount of humus is determined by the Turin method, nitrogen by the Keldal method, phosphorus in the general form by the Ginzburg method, potassium by the Smitht method, nitrate nitrogen in mobile forms by the ionoselective method, ammonium nitrogen by the Nessler reagent, phosphorus by the Machigin method, potassium by the flame photometric chromatography method, heavy metals by the atomic absorption method by AAS determined in the lamp apparatus [5-10].

3 Results and discussion

The takyr-meadow soils distributed in Kasbi district are formed in layered alluvial deposits in the middle part of the Kashkadarya delta, in the Central Asian province of the Turon
subtropical climate region, in the region of light takyr soils (farm "Pakhtakor" in Kasbi district). The amount of humus in the plowed layer of the described irrigated takyr-meadow soils is 0.555-0.947%, in the sub-plotted layer it is 0.515-0.739%, and it decreases towards the lower layers. It was noted that the total amount of nitrogen in these soils is 0.045-0.069% in the tillage layer, 0.041-0.054% in the sub-tillage layer, and decreases proportionally to humus in the lower layers. The amount of mobile nitrogen is 27.5-38.4 mg/kg in the driving layer, 21.6-24.1 mg/kg in the sub-driving layer, decreases towards the lower layers, and according to the level of provision, it is divided into very low, low and moderate groups in the genetic layers. Belongs to The ratio of carbon to nitrogen was observed in the range of 5.0-9.5. The amount of total phosphorus is 0.122-0.152% in the driving layer, 0.102-0.131% in the sub-driving layer, and decreases towards the lower layers. Mobile phosphorus was recorded in the range of 15.2-25.2 mg/kg in the driving layer and 11.3-21.5 mg/kg in the sub-driving layer. The total amount of potassium is 1.12-2.05% in the driving layer, 1.02-1.72% in the sub-driving layer, and decreases towards the lower layers. Exchangeable potassium is in the range of 231-321 mg/kg in the driving layer, 220-301 mg/kg in the sub-driving layer, decreasing towards the lower layers.

In the lower part of the Kashkadarya delta, the amount of humus in the plowed layer of the irrigated meadow soils composed of layered alluvial deposits is 0.469-0.769%, and in the sub-ploughed layer it decreases to 0.431-0.672% towards the lower layers. It was noted that the total amount of nitrogen in these soils is 0.36-0.072% in the tillage layer, 0.034-0.062% in the sub-tillage layer, and decreases towards the lower layers. The amount of mobile nitrogen is 23.1-37.9 mg/kg in the driving layer, 12.9-25.5 mg/kg in the sub-driving layer, decreases towards the lower layers, and according to the level of supply, it is divided into very low, low and moderate groups in the genetic layers. Belongs to The ratio of carbon to nitrogen was observed in the range of 5.2-8.3. The amount of total phosphorus is 0.074-0.152% in the driving layer, 0.063-0.132% in the sub-driving layer, and decreases towards the lower layers. Mobile phosphorus was recorded in the range of 12.9-32.5 mg/kg in the driving layer and 11.2-23.4 mg/kg in the sub-driving layer. The total amount of potassium is 1.15-2.05% in the driving layer, 1.03-1.95% in the sub-driving layer, and decreases towards the lower layers. Exchangeable potassium is in the range of 207-374 mg/kg in the driving layer, 190-334 mg/kg in the sub-driving layer, decreasing towards the lower layers.

Also, the region of light-colored takyr soils consists of alluvial deposits, the upper part of the Kashkadarya river delta, the irrigated takyr-meadow soils of the "Galaba" massif of Kasbi district, the amount of humus in the arable layer is 0.363-0.386%, and in the sub-arable layer is 0.319-0.553%, decreases towards the lower layers. It was noted that the total amount of nitrogen in these soils is 0.028-0.051% in the tillage layer, 0.026-0.045% in the sub-tillage layer, and decreases proportionally to humus in the lower layers. The amount of mobile nitrogen is 21.9-34.7 mg/kg in the driving layer, 17.9-31.6 mg/kg in the sub-driving layer, decreases towards the lower layers, and according to the level of supply, it is divided into very low, low and moderate groups in the genetic layers. Belongs to The ratio of carbon to nitrogen was observed in the range of 5.0-7.8. The amount of total phosphorus is 0.126-0.156% in the driving layer, 0.114-0.138% in the sub-driving layer, and decreases towards the lower layers. Mobile phosphorus was recorded in the range of 25.3-23.7 mg/kg in the driving layer and 15.6-26.9 mg/kg in the sub-driving layer.

The total amount of potassium is 1.21-1.44% in the driving layer, 1.12-1.23% in the sub-driving layer, and decreases towards the lower layers. Exchangeable potassium is in the range of 270-389 mg/kg in the driving layer, 231-289 mg/kg in the sub-driving layer, decreasing towards the lower layers. The genetic layers of the studied cuttings belong to the groups with very low, low and moderate supply of mobile phosphorus and exchangeable potassium.
The amount of cadmium element dispersed in the irrigated takyr-meadow soils of the "Pakhtakor" massif of Kasbi District is 0.14 mg/kg in the 0-2 cm layer, 0.15 mg/kg in the 2-10 cm layer, and 0.15 mg/kg in the 10-20 cm layer. On average, up to 0.14 mg/kg, up to 0.13 mg/kg in the 20-30 cm layer, and up to 0.17 mg/kg in the 30-50 cm layer. 0.12 mg/kg in the 0-2 cm layer, 0.12 mg/kg in the 2-10 cm layer, up to 0.11 mg/kg in the 10-20 cm layer, 0.14 mg/kg in the 20-30 cm layer of irrigated meadow soils. Kg, distribution of up to 0.13 mg/kg in the 30-50 cm layer was determined (Figure 1). The average amount of cadmium in the irrigated meadow soils distributed in the lower part of the Kashkadarya river delta is 0.12 mg/kg in the 0-2 cm layer, 0.12 mg/kg in the 2-10 cm layer, up to 0.13 mg/kg in the 10-20 cm layer, 20 Up to 0.14 mg/kg was observed in the -30 cm layer, and up to 0.15 mg/kg in the 30-50 cm layer. In these soils, almost the same amount of cadmium was observed from the upper layer towards the lower layers.

**Fig. 1.** Average amount of cadmium (mg/kg) scattered in the soils of the "Pakhtakor" massif of Kasbi district (Uzbekistan).

The cadmium element in the 0-2 cm layer of irrigated takyr-meadow soils distributed in the "Galaba" massif of Kasbi District is 0.13 mg/kg, in the 2-10 cm layer is 0.12 mg/kg, and in the 10-20 cm layer is up to 0.11 mg/kg, accumulation of up to 0.09 mg/kg in the 20-30 cm layer and 0.09 mg/kg in the 30-50 cm layer was observed.

Cadmium element in irrigated grassland soils is 0.11 mg/kg in the 0-2 cm layer, 0.10 mg/kg in the 2-10 cm layer, up to 0.12 mg/kg in the 10-20 cm layer, 0.11 in the 20-30 cm layer up to mg/kg, accumulation of up to 0.12 mg/kg in the 30-50 cm layer was observed (Figure 2).
4 Conclusions

The negative effects of toxicants on the amount of nutrients and humus of irrigated takyr-meadow and meadow soils were studied. It was observed that the toxic element cadmium did not exceed the permissible amount. However, the accumulation of cadmium element in the soil not only affects the properties of the soil, but also leads to the stress of humus and nutrients. In the irrigated takyr-meadow, meadow and irrigated meadow soils in the lower part of the Kashkadarya river delta in the region of pale takyr soils, which was studied above, the fertility of the soils is very low and insufficient, as a result of anthropogenic factors, the increase of the element cadmium from the driving layer to the lower layers is the reason for the stress state.

In order to prevent such negative consequences and grow clean ecological agricultural products, we need to bring new, modern, low-waste technologies to industrial enterprises, reduce the amount of waste released into the environment, and create a clean ecological environment.

References

4. Decree of the President of the Republic of Uzbekistan dated 30.12.2021 No. PD-76 "On measures to organize the activities of state bodies in the field of environmental protection and environmental control".


