The content of heavy metals in the gray-brown soils of the karakul pasture Karnabchul in Samarkand, Uzbekistan

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Abstract. This article presents the results of X-ray fluorescence analysis (XFA) of gray-brown soils on the content of heavy metals nickel, antimony, copper, zinc, arsenic, lead, vannadium, chromium, manganese, iron, cobalt and aluminum of the karakul pasture Karnabchul. The dynamics of the distribution of heavy metals over the soil profile of gray-brown soils is described in graphic images. The drawings depict the landscape of the karakul breeding pasture Karnabchul and the soil section of gray-brown soils.

1 Introduction

Gray-brown soils are used mainly under pastures. Karnabchul with gray-brown soils is specialized for karakul breeding pastures. Only Karakul sheep are able to survive the harsh climatic conditions of Karnabchul. Unfortunately, in recent years, as a result of habitat degradation, an increase in heavy metals in the soil profile and soil degradation of the Kurakul pastures, the productivity, viability, and reproductive potential of Karakul sheep have decreased.Only rational nutrition can increase the adaptive potential, reduce embryonic losses, normalize the immunological status and increase the reproducibility of Karakul sheep.

In order to develop technology for optimizing reproduction, preventing degradation, accumulation of harmful heavy metals and desertification of gray-brown soils, a comprehensive study of their agrochemical characteristics is necessary.The purpose of our work, by studying the agrochemical properties and the content of heavy metals in the soil profile of gray-brown soils of karakul pastures of Karnabchul, to develop a set of agrotechnical techniques aimed at eliminating the high content of harmful, heavy metals in the soil profile of gray-brown soils, their unfavorable physical and mechanical properties (density, structure, granulological composition), and also including the introduction of a fertilizer system for desert phytomeliorative plants, such as black saxaul, izen, chogon, wormwood, sandy esparcet and others.

Weak soaking of gray-brown soils limits the soil formation process, including the process of humification. The weak manifestation of biological processes causes the short

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duration of humus formation. In this regard, the humus content here is below 1%. The composition of humus is fulvate. These features also affect the content of heavy metals in gray-brown soils. The low humus content contributes to a greater accumulation of heavy metals harmful to the biota of the soil and the environment.In Karnabchul, the average annual precipitation is 80-100 mm . The coordinates of the experiment venue are 39040’53.1”N and 65047’22.5”E. The process of soil formation occurs under the influence of physical processes - freezing in winter and desiccation in summer, during chemical processes - chemical weathering, formation of carbonates and gypsum, as well as cementation of their particles, during physico-chemical processes-salinization. The absorbed cations are dominated by calcium and magnesium cations, which transmit an alkaline environment to the soil, and which lead to an increase in heavy metals such as vanadium, chromium, manganese, iron, cobalt and aluminum at a depth of about half a meter. The thickness of the soil horizon is very weak 40-50 cm, gypsum accumulates below, the soil profile is poorly differentiated.

Fig. 1. The landscape of the karakul breeding pasture Karnabchul.

Fig. 2. Soil section of gray-brown soils of karakul breeding pasture Karnabchul.

2 Materials and methods

X-ray fluorescence analysis (XFA) was used to conduct soil studies. XFA is a new promising multi-element and non-destructive method of analysis. The method of agrochemical examination of the soil of the XFA is important for the implementation of research works to increase the soil fertility of gray-brown soils of the karakul pasture Karnabchul and more efficient and environmentally safe use of fertilizers. Nevertheless, the determination of soil-agrochemical indicators by extraction, that is, by the express-non-destructive multi-element method of XFA makes it possible to obtain more effective information, an acceptable level of costs, contributing to the preservation of soil fertility, environmental and food security of the rape of karakul breeding pasture farms.

3 Results and discussion

An effective method of multi-element analysis of X-ray soils was carried out on the device of a multichannel X-ray spectrometer of the SPECTROSCAN MAX-GV type. Sample preparation of soil samples required good homogeneity of soil samples and preparation of durable tablets by pressing. To ensure the homogeneity of soil samples, the soil was dried to room temperature, ground in a coffee grinder and sifted through a sieve with 0.25 mm holes. For pressing, soil weighing 5 g was taken, placed in a mold cell and pressed at 120 MPa for 2-3 minutes. Ready-made tablets of up to 12 pieces were placed in containers of the SPECTROSCAN MAX-GV vacuum chamber, the device was launched using computer software. The analysis of samples in the SPECTROSCAN MAX-GV is carried out in a vacuum chamber, if the soil sample is fragile and crumbles under the influence of a pressure surge, then these crumbs clog the vacuum system, valve and pump, which leads to emergency stops and long maintenance work on the spectrometer.

Soil samples were taken from every 20 cm of the soil profile (0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm, 80-100 cm) of gray-brown soils, for this purpose a soil section was laid on the karakul breeding pasture of Karnabchul, Samarkand viloyat, Republic of Uzbekistan.Research results. X-ray fluorescence analysis (XFA) of gray-brown soils of the karakul pasture Karnabchul showed that in the upper horizon of 0-20 cm the content of heavy metals nickel and antimony is greater than in the upper layers of serozem soils. If the nickel content in serozem soils at a depth of 0-20 cm averages 55 mg/kg, then in gray-brown soils it showed 69 mg/kg. And if the content of heavy antimony metal in the upper layer of 0-20 cm serozem soils averages 220 mg / kg, then in gray-brown soils -284 mg / kg. According to the soil profile of gray-brown soils, these two heavy metals behave almost identically. The nickel and antimony content in the soil horizon of 20-40 cm slightly increased than in the upper horizon, amounting to 72.65 mg/kg and 303.4 mg/kg, respectively. Even deeper at a depth of 40-60 cm of gray-brown soils, an increase in the content of heavy metals nickel and antimony was observed, amounting to 67.26 mg/kg and 293 mg/kg. Further, the heavy metal nickel at a depth of 60-80 cm in gray-brown soils decreased to 56 mg/kg, and at a depth of 80-100 cm reached its original content on the upper layer of 69 mg/kg. The heavy metal antimony increased at a depth of 60-80 cm and averaged 315 mg/kg, then at a depth of 80-100 cm continued to increase, surpassing the content on the upper layer, averaging 409 mg/kg (Figures 1 and 2).

The same pattern of distribution of heavy metals along the soil profile of gray-brown soils, similar to nickel and antimony, was traced in the distribution of heavy metals along the soil profile, such as copper, zinc, arsenic and lead. But there was a difference from nickel and antimony, their content in gray-earth soils is greater than in gray-brown soils. If the content of copper, zinc, arsenic and lead in the upper horizon of 0-20 cm of gray-earth soils averages 40 mg/kg, 200 mg/kg, 14.5 mg/kg and 250.5 mg/kg, then these indicators in

the upper layer of gray-brown soils were 38 mg/kg, 75 mg/kg, 11 mg/kg and 13 mg/kg. Such differences in the content of heavy metals in gray-earth and gray-brown soils require further research.

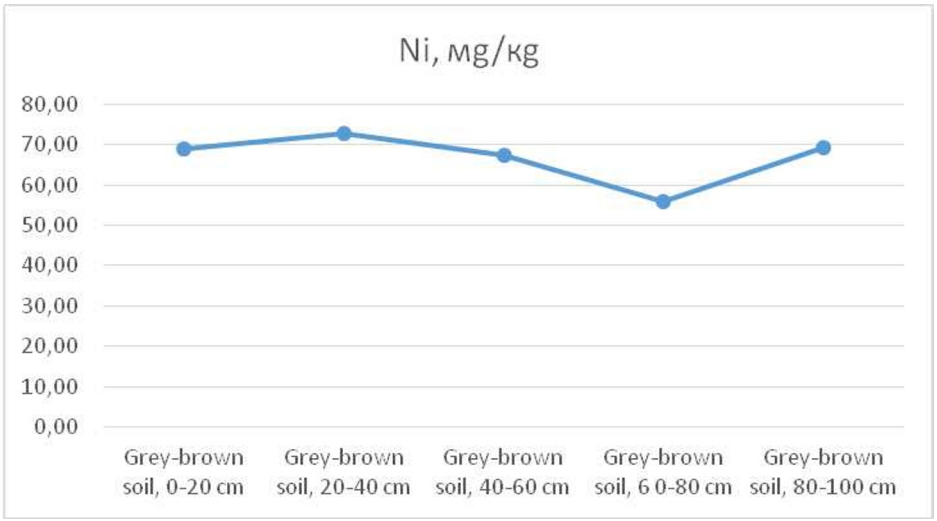

Fig. 3. Nickel content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

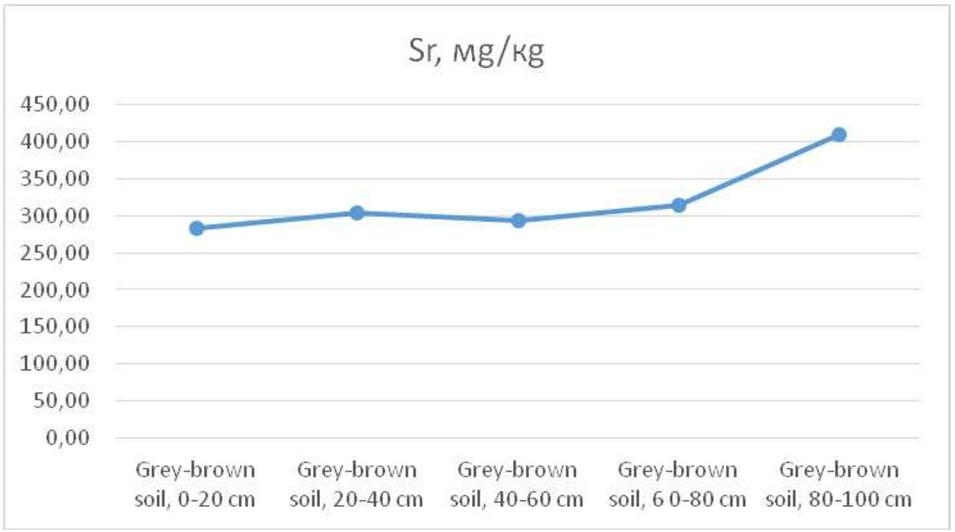

Fig. 4. Antimony content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

At a depth of 20-40 cm of gray-brown soils, the content of all four heavy metals increased, the content of copper was 39 mg/kg, zinc 76 mg/kg, arsenic 16 mg/kg and lead 28 mg/kg. No lead was found in gray-brown soils at a depth of 40-60 cm, and the content of copper, arsenic and zinc decreased (38 mg/kg, 9 mg/kg and 75 mg/kg), then at a depth of 80-60 cm the content of copper, zinc and lead increased (43 mg/kg, 76 mg/kg and 2.5 mg/kg), and the arsenic content remained unchanged (9 mg/kg). In the lower layer of 80-100 cm of gray-brown soils, the content of heavy metals zinc and

arsenic increased (76.5 mg/kg and 11 mg/kg), the copper content decreased (36 mg/kg), and the lead content remained unchanged (2.5 mg/kg).

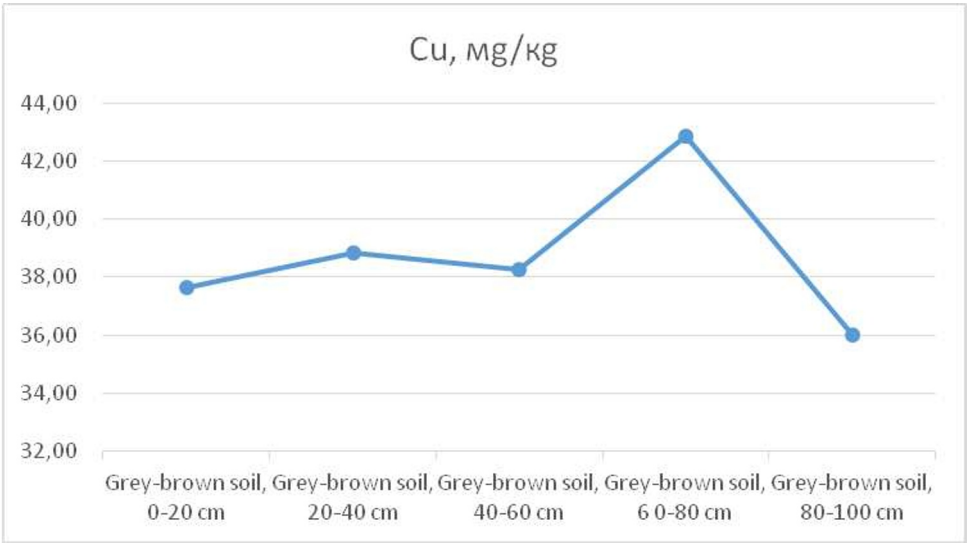

Fig. 5. Copper content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

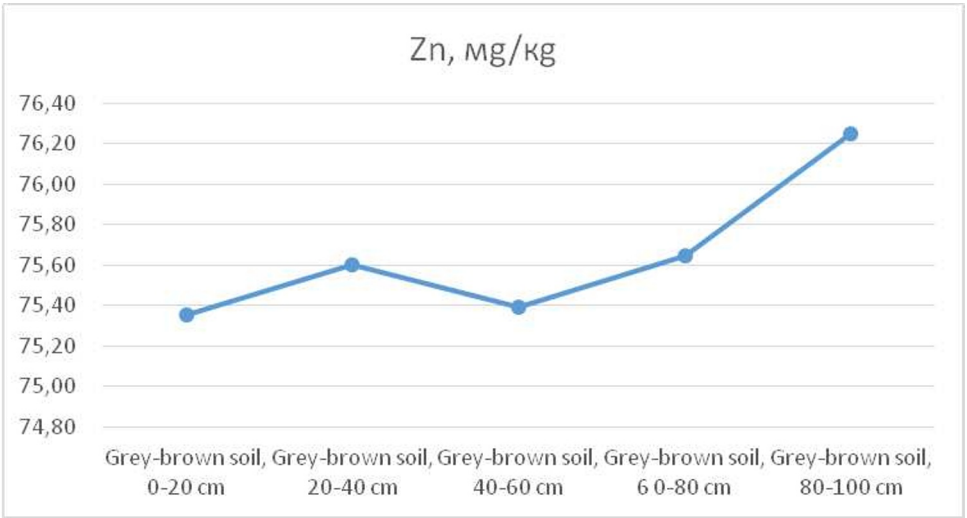

Fig.6. Zinc content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

Heavy metals vanadium, chromium, manganese, iron, cobalt and aluminum at a depth of 0-20 cm in gray-brown soils contained slightly less (83 mg/kg, 78 mg/kg, 639 mg/kg, 3.7%, 6 mg/kg and 11.2%) than in gray-earth soils (86 mg/kg, 81 mg/kg, 800 mg/kg, 4%, 7.9 mg/kg and 11.4%), but according to the distribution of gray-brown soils along the soil profile, they behaved differently than other heavy metals.These heavy metals under the upper layer of gray-brown soils, at a depth of 20-40 cm, decreased against the heavy metals nickel, antimony, copper, zinc, arsenic and lead.

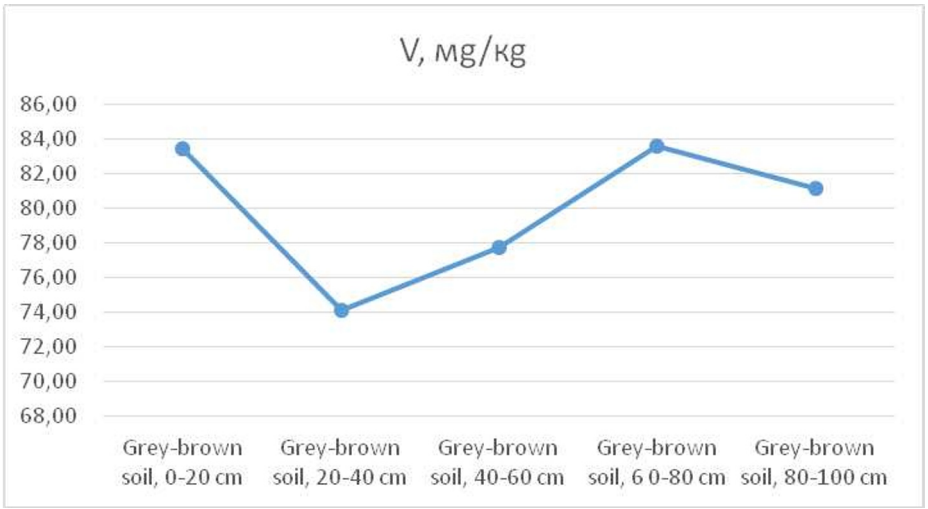

Fig. 7. Vannadium content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

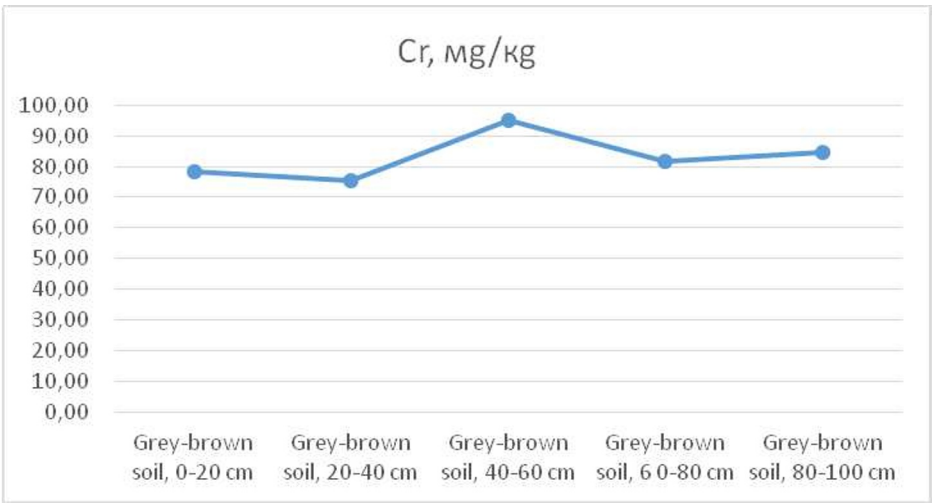

Fig. 8. Chromium content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

The content of heavy metals vanadium, chromium, manganese, iron, cobalt and aluminum under the upper layer of the soil, at a depth of 20-40 cm, was 74 mg/kg, 75 mg/kg, 549 mg/kg, 3.37%, 4.3 mg/kg and 10.5%. Even deeper at a depth of about half a meter (40-60 cm), there was again an increase in these heavy metals vanadium, chromium, manganese, iron, cobalt and aluminum (77.7 mg/kg, 95.12 mg/kg, 573 mg/kg, 3.66%, 4.41 mg/kg and 11.23%).This is due to the absorption of these heavy metals by the soil-absorbing complex (SAC). At a depth of 60-80 cm of gray-brown soils, the heavy metals vanadium, manganese, iron and cobalt continued to increase (84 mg/kg, 630 mg/kg, 3.75% and 6.9 mg/kg), when the content of heavy metals chromium and aluminum decreased (11.5 mg/kg and 10.5%). In the horizon of 80-100 cm of gray-brown soils, the content of heavy metals vanadium and cobalt decreased (81 mg/kg and 5 mg/kg), and the content of

heavy metals chromium, manganese and aluminum increased (84.5 mg/kg, 643 mg/kg and 11%), and the iron content remained almost unchanged (3.74 %).

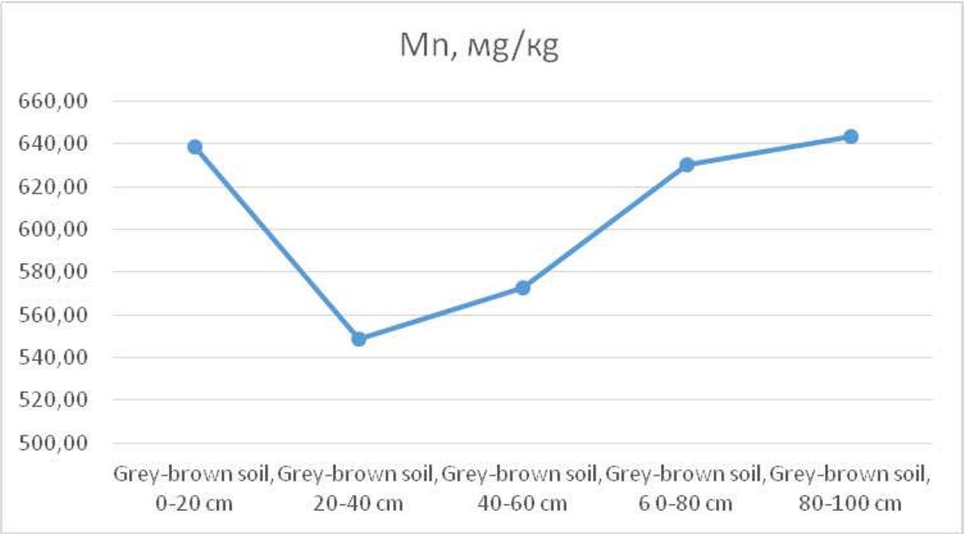

Fig. 9. Manganese content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

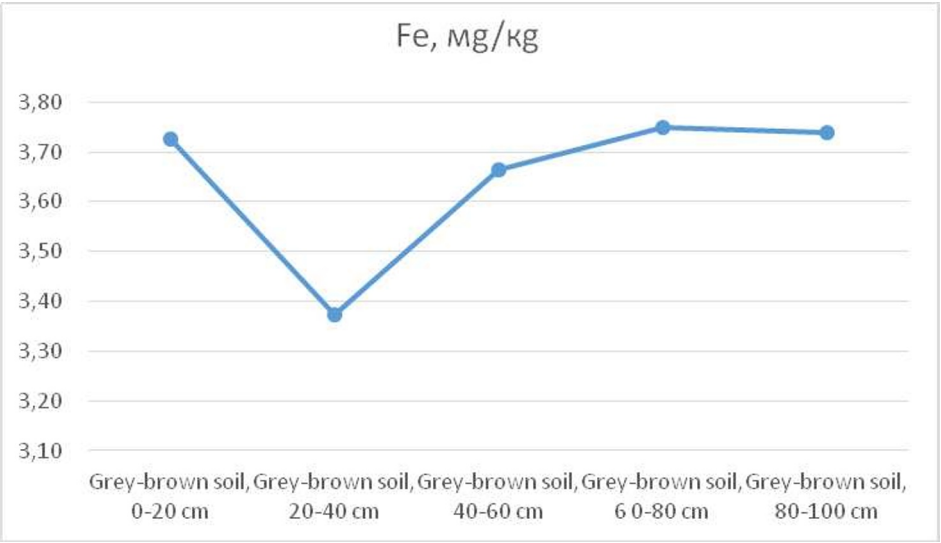

Fig. 10. Iron content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

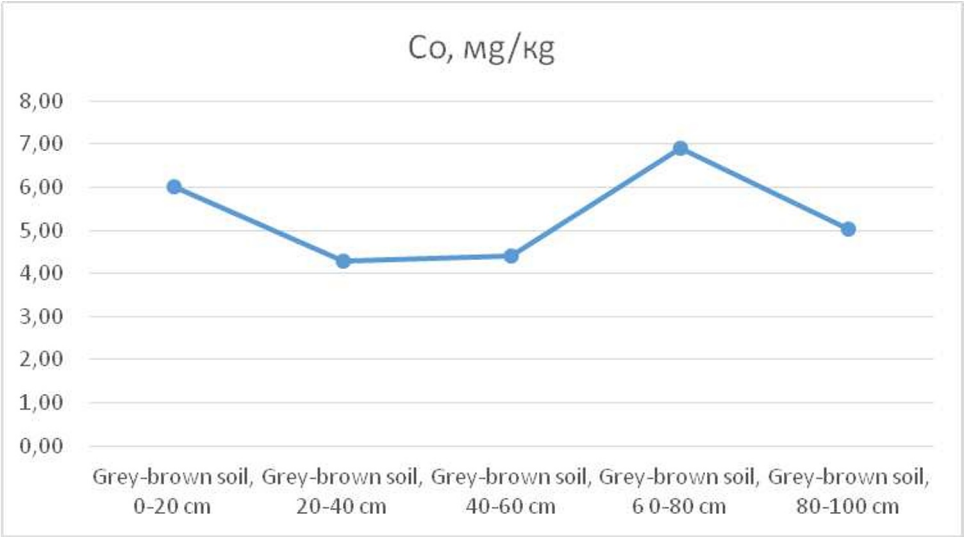

Fig. 11. Cobalt content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

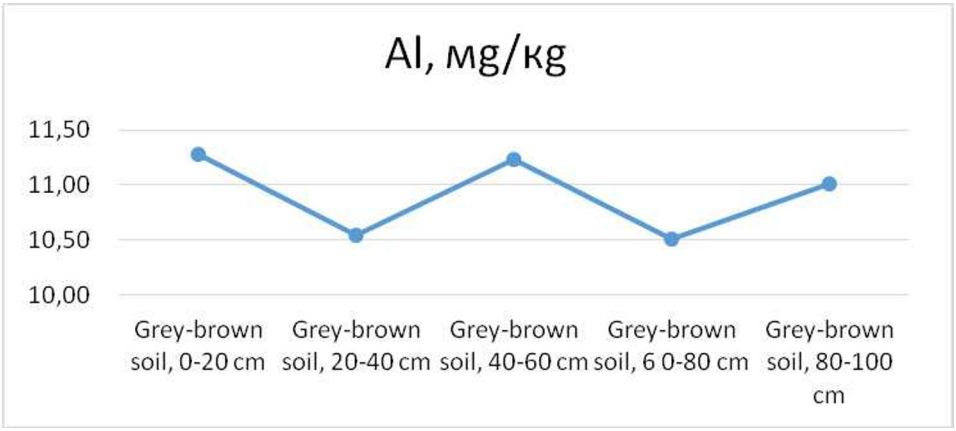

Fig. 12. Aluminum content according to the soil profile of gray-brown soil of the karakul breeding pasture Karnabchul.

4 Conclusions

To prevent degradation, accumulation of harmful heavy metals and desertification of gray-brown soils, a comprehensive study of their agrochemical characteristics is necessary. With the help of an all-sided study of agrochemical properties and determination of the content and distribution of heavy metals in the soil profile of gray-brown soils of karakul breeding pastures of Karnabchul, it is possible to develop scientifically-based methods for increasing the fertility of these soils, providing for the improvement of the technology of cultivation of phytomeliorative desert plants on these soils, which lead to an increase in the productivity of karakul breeding desert pastures of Karnabchul.

References

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