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The Effect of Organic and Biological Fertilizers on the Movement of Heavy Metals (Cu, Zn) in the Soil-Plant System

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Abstract: The article experimentally proves that the use of Teria-S bacterial fertilizer, K-Gumat organic fertilizer, and Serhosil biopreparation during the cultivation of wheat plants in soil conditions contaminated with industrial waste belonging to the Almalyk Mining and Metallurgical Combine (Joint Stock Company) reduced the amount of heavy metals (Cu, Zn) in the organs of the grown wheat plants.

Keywords: “Almalyk Mining and Metallurgical Combine” JSC, Teria-S, Serhosil, K-Gumat, winter wheat.

Introduction

Agriculture is a complex branch of biological management of the environment, and its tasks are to increase biological productivity in agricultural production, while preserving the soil and its natural fertility, rational use and reproduction of agricultural resources [1, 2].

Heavy metals are divided into two groups - toxic and "microelements" used in small quantities in agriculture [3]. Microelements such as cobalt, copper, iron, manganese, molybdenum, nickel and zinc are essential for the vital activity of living organisms in small concentrations (0.001% of dry

cell mass and below), and their toxicity increases with increasing concentration in the cell. For this reason, in most cases, these elements are called microelements in small concentrations, and in high concentrations they are described as heavy metals. Elements such as Cd, Pb, Sn, Hg and Ag, since they do not perform any biological functions, are included in the category of metals that have a harmful effect even at low concentrations [4; 5].

According to the hygienic standards for the quality and safety of food raw materials, food products (SanPiN 2.3.2.500-96), the REM for Cu in general grain, including wheat, is 10 mg/kg and Zn is 50 mg/kg [6].

Gluten (glue) in wheat grains is one of the most important indicators of grain quality. The amount of gluten in the grain varies depending on the biological characteristics of the variety, the environmental conditions in which the wheat grows, environmental factors, and technological methods. As a trace element, gluten participates in biochemical processes in living organisms, but in excess can be toxic [7].

In the studies of Q.Y.Huang et al., plant seeds were treated with symbiotic PGPR (plant growth promoting rhizobacteria) and were found to adsorb Cu and Cd from the soil [8]. W.Hou et al. (2013) also recommended the use of Bacillus sp. USTB-O strain to alleviate stress and promote growth in wheat cultivation under the harmful effects of Cu metal [9].

Research methodology

The research was conducted in the Tashkent region, in the vicinity of the city of Almalyk and the Almalyk Mining and Metallurgical Plant JSC, as well as in the agricultural areas of the plant.

K-Humat organic fertilizer. Angren coal was oxidized with hydrogen peroxide, and then the oxidized product was isolated by extraction using a 1% KOH solution. Its concentration was 3.83%. The resulting solution was diluted to 0.1% and added to the soil at a rate of 200 l/ha [10].

Teria-S is a new generation of environmentally friendly bacterial fertilizer with a complex effect. Composition: multi-specific soil bacteria resistant to saline and adverse weather conditions. Method of application: intended for pre-sowing treatment of seeds. Application rate - 1.5 l / ha [11].

Serhosil - a biological preparation with a complex effect. Composition: green algae of the Scenedesmus species. Application rate - foliar spray. Application rate - 10 l / ha (used 2 times during the growing season) [12].

The amount of heavy metals in the soil was determined using the 7500 Series device using the methods "Determination of the elemental composition of rocks, soil, soil and subsoil sediments using the inductively coupled plasma atomic emission method and the inductively coupled plasma mass spectral method", and the mobile forms of heavy metals were determined using the atomic sorption (rd-52.18-289-90) method.

Analysis and results

In conditions of soil contaminated with heavy metals, the accumulation of heavy metals in both vegetative and generative organs of wheat plants under the influence of organic and biological fertilizers was studied, and as a result, a decrease in the accumulation of heavy metals was observed. According to the results, when the soils were treated with mineral and K-Humat organic fertilizers, the amounts of heavy metals in the roots of wheat plants decreased by 18.2% Cu and 52% Zn compared to the control variants (Table 1).

In the variants where the soils were treated with mineral fertilizers before wheat planting and wheat seeds were treated with Teria-S bacterial fertilizer, it was found that the heavy metal elements in the roots of winter wheat plants decreased by 21% Cu and 53% Zn compared to the control.

Table 1 Changes in the amount of heavy metals in the vegetative, generative organs and grains of winter wheat plants under the influence of organic and biological fertilizers, (average, n=3)

№	Experience options	Cu, mg/kg			Zn, mg/kg		
		Root	Stem	Grain	Root	Stem	Grain
1	Control, NPK	77	75	64	361	340	267
2	NPK+ K-Humat	63	57	52	190	177	85
3	NPK +Teria-S	61	43	50	170	114	72
4	NPK +K-Humat+ Teria-S+Serhosil	60,5	39	46	165	113	60

According to the results of the experiment, it was found that the amounts of heavy metal elements in the roots of wheat plants in the experimental variants where the soils were treated with mineral fertilizers before sowing wheat and a complex of organic and biofertilizers K-Humat, Teria-S, Serhosil was used, compared to the control, decreased by 21.4% Cu and 54% Zn.

When the soils were treated with K-Humat organic fertilizer, it was found that the amounts of heavy metals in the stems of wheat plants decreased by 24% Cu and 66% Zn compared to the control variants. In the variants where the soils were treated with mineral fertilizers before sowing wheat and wheat seeds were treated with Teria-S bacterial fertilizer, it was found that the amounts of heavy metal elements in the stems of winter wheat plants decreased by 23% Cu and 66.4% Zn compared to the control.

In the experimental variants where the soils were treated with mineral fertilizers before sowing wheat, and a complex of organic and biofertilizers K-Humat, Teria-S, Serhosil was used, it was found that the amounts of heavy metals in the stems of winter wheat plants decreased by 25% for Cu and 66.7% for Zn compared to the control. The reduction in the accumulation of heavy metals in the roots and stems of wheat plants under the influence of organic and biological fertilizers also had an effect on the composition of the grains, and it was found that the amounts of heavy metals in the composition of the grains decreased.

According to the results, when the soils were treated with mineral and K-Humat organic fertilizers before sowing wheat, the amounts of heavy metals in wheat grains decreased by 18% Cu and 68% Zn compared to the control variants. In the variants where the soils were treated with mineral fertilizers and wheat seeds with Teria-S bacterial fertilizer, the amounts of heavy metal elements in the stems of winter wheat plants decreased by 22% Cu and 73% Zn compared to the control.

In experimental variants where the soils were treated with mineral fertilizers before sowing wheat and a complex of organic and biofertilizers K-Humat, Teria-S, Serhosil was used, it was found that the amounts of heavy metal elements in the grain composition of wheat plants decreased by 28% Cu and 77.5% Zn compared to the control.

Conclusion

From the results of experiments conducted to study the effect of the use of organic fertilizers, biological fertilizers and their complexes on the accumulation of heavy metals in soils and wheat plant organs in soils contaminated with heavy metals, it can be concluded that the variants of the K-Gumat, Teria-S, Serhosil organic and biological fertilizer complexes effectively reduce the mobile forms of heavy metals Cu and Zn in soils, wheat plant organs and grains, due to the formation of the strongest complexes with heavy metals and humic substances, and due to the absorption of heavy metals by active bacteria in the composition of the Teria-S bacterial fertilizer and an increase in the number of bacteria.

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