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Effect of Organic and Biological Fertilizers on Biometric Indicators of Plant Growth, Development and Yield of Winter Wheat in Soils Contaminated With Heavy Metals

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Abstract: The article presents data on improving biometric indicators of growth and development of winter wheat plants in soils contaminated with heavy metals, as well as increasing the yield and quality of wheat grain using a complex of mineral, organic and biological fertilizers K-Gumat, Teria-S, Serhosil.

Key words: soil, heavy metals, winter wheat, biometric indicators, yield, grain quality, NPP, K-Gumat, Teria-S, Serhosil.

INTRODUCTION

Failure to adhere to the requirements for cultivating agricultural crops, the uncontrolled use of chemical agents and fertilizers, and the disruption of soil-ecological conditions contribute to the increase in degraded land areas. Among these issues, soil protection holds a unique importance. Considering that humanity relies on plants grown in soil for essential food products, the significance

of soil protection becomes clear. This goes beyond merely producing food or supplying raw materials for industry, as soil also plays an irreplaceable ecological role in biogeocenosis and the biosphere. Therefore, soil conservation is one of the most pressing environmental issues of our time.

Literature Review

Wheat is one of the most widely cultivated cereal grains globally and is a staple food for human consumption. Environmental factors such as the harmful effects of heavy metals, salinization, and drought severely impact the growth and development of wheat, leading to reduced yields, as noted by O. Pintilie, M. Zaharia, and others [1].

According to Z. Ekin, one of the most effective methods for enhancing plant growth and development is the use of biologically active substances, such as humic substances and plant growth-promoting rhizobacteria [2]. As noted by J. Mishra et al., these rhizobacteria offer substantial benefits, as they not only improve soil quality and promote plant growth but also detoxify heavy metals in the soil [3]. M.M. Ovcharenko et al. found that humic substances support plant growth and development by increasing soil biological activity [4]. According to Y.N. Vodianitsky, humic substances are among the most complex and biologically active organic compounds in the soil, also aiding in the activation of plant growth-promoting rhizobacteria [5].

Based on the above information, the effects of applying mineral, organic, bio-fertilizers, and their combinations on the biometric indicators of growth and development of winter wheat were studied in soils contaminated with heavy metals.

Research Methodology

K-Gumat organic fertilizer: Composition includes organic substances, humic, and fulvic acids. Application method: applied to soils prior to seed planting. Application rate: 200 L/ha.

Teria-S: A new-generation eco-friendly bacterial fertilizer with a broad impact. Composition includes multi-functional soil bacteria resistant to salinity and adverse weather conditions. Application method: intended for pre-sowing seed treatment. Application rate: 1.5 L/ha.

Serhosil: A bio-preparation with a complex effect. Composition includes green algae of the Scenedesmus genus. Application method: foliar spray, applied twice during the vegetation period. Application rate: 10 L/ha.

All phenological observations and biometric measurements conducted on winter wheat followed established methodological guidelines [6, 7].

Analysis and Results

In soil contaminated with heavy metals, the effects of mineral, organic, and bio-fertilizers on the biometric indicators of growth and development of winter wheat were studied during early ripening (May) and ripening (June).

In trials conducted in contaminated soils, winter wheat showed improved root development in plots treated with mineral fertilizer and K-Gumat organic fertilizer before planting. Under the influence of K-Gumat, the average fresh root weight reached 3.41 (±1.33) g, and the average dry root weight reached 0.83 (±0.30) g, representing increases of 2.78 g and 0.46 g, respectively, compared to the control. For wheat treated with Teria-S bacterial fertilizer before planting, the average fresh root weight was 1.37 (±0.22) g, and the average dry weight was 0.46 (±0.05) g, which were 0.74 g and 0.19 g higher than the control, respectively. In another trial where soil was treated with mineral fertilizer and a combination of K-Gumat, Teria-S, and Serhosil bio-fertilizers, the average fresh root weight increased by 1.97 g and the average dry weight by 0.29 g over the control group.

Among the experimental options, a positive effect of K-Gumat on the development of wheat plant stalks was observed in the options where the soil was treated with mineral fertilizer and K-Gumat organic fertilizer before planting wheat. It was determined that the average wet weight of wheat stalks increased by 43.64 g and the average dry weight by 16.88 g under the influence of K-Gumat organic fertilizer compared to the control variant. It was found that the average wet weight of wheat stalks treated with Teria-S bacterial fertilizer before planting on wheat seeds increased by 15.56 g and average dry weight by 3.82 g compared to the control option. In the experimental variant where mineral fertilizers were applied to the soil before sowing wheat and K-Gumat, Teria-S and Serhosil organic and biofertilizer complex were used, it was found that the average wet weight of wheat stalks increased by 27.66 g and the average dry weight by 9.22 g compared to the control (Table 1).

Table 1.

Effect of organic and biological fertilizers on biometric indicators of winter wheat plant (May 2022, average n=5)

№	Experience options	Weight of roots, g		Weight of stalks, g	
		wet	dry	wet	dry
1	Назорат NPK	0,63±0,07	0,27±0,02	17,93±2,02	8,84±2,03*
2	NPK+ K- Gumat	3,41±1,33*	0,83±0,30*	61,57±3,4*	25,72±2,4*
3	NPK +Teria-S	1,37±0,22*	0,46±0,05*	33,49±2,4*	12,66±1,9*
4	NPK +K- Gumat + Teria-S+ Serhosil	2,55±1,04*	0,56±0,23*	45,59±2,5*	18,06±2,1*

Explanation: * P≤0,05 – reliable relative to control

Monitoring of biometric indicators during the early ripening period of wheat, it was observed that the average wet and dry weight of roots and stems of plants in the 2nd option, i.e. the options where the soils were treated with mineral fertilizer and K-Gumat organic fertilizer, compared to the other options, were studied in the experiment.

The growth and development of wheat plants and the changes in biometric indicators during the ripening period (in June) were also studied (Table 2).

In all studied experimental options, soils were treated with mineral fertilizers before planting. According to the obtained results, the average weight of wheat roots under the influence of K-Gumat organic fertilizer is 1.27(±0.47) g. was 1.11 g compared to the control option. was found to have increased.

The average weight of stems compared to the control options is 9.63 g. ha, the average weight of spikes is 1.17 g. ha, the average length of stems is 17 cm. ha, it was found that the average length of spikes increased by 1 cm.

Table 2.

Effect of organic and biological fertilizers on biometric indicators of winter wheat plant (June 2022, average n=5)

№	Experience options	Root weight, g	Stem weight, g	Stem length, cm	Spike length, cm	Spike weight, g
1	Назорат NPK	0,16±0,05	4,72±1,05	59,3±1,5	7,3±0,43	0,59±0,27
2	NPK+ K-Gumat	1,27±0,47*	14,35±3,7*	76,3±1,5*	8,3±0,43*	1,76±0,38*

3 NPK +Teria-S 0,36±0,09 6,72±2,07* 78,7±2,9* 8,0±0,67* 1,73±0,38*

4 NPK +K-Gumat+ Teria-S+ Serhosil 2,2±0,90* 20,83±3,8* 86,7±0,9* 9,2±0,23* 1,89±0,16*

Explanation: * P≤0,05 – reliable relative to control

The average weight of wheat roots under the influence of Teria-S bacterial fertilizer was 0.36 (±0.09) g and it was found that it increased by 2.04 g compared to the control option. It was found that the average weight of stems increased by 2 g, the average weight of spikes by 1.14 g, the average length of stems by 19.4 cm, and the average length of spikes by 1.14 cm.

It was determined that the average weight of wheat roots was 2.2 (±0.90) g and increased by 0.6 g compared to the control option under the influence of K-Gumat, Teria-S, Serhosil organic fertilizer and biofertilizer complex. It was found that the average weight of stems increased by 16.1 g, the average weight of spikes increased by 1.3 g, the average length of stems increased by 27.4 cm, and the average length of spikes increased by 1.9 cm.

Based on the application of NPK, organic K-Gumat, Teria-S and Serhosil biofertilizers, it was found that the yield of wheat increased by 7 ts/ha compared to the control and the grain quality improved. Compared to the control, the amount of natural indicators of winter wheat grain increased by 9.9%, transparency by 4.8%, gluten content by 6.6%, IDK by 16.2% in the variants with NPK, K-Gumat, Teria-S and Serhosil fertilizer complexes. ha, weight of 1000 pieces - increased by 7%.

Conclusion

According to the results presented above, the use of K-Gumat, Teria-S, Serhosil organic fertilizers and biofertilizers complex in the cultivation of wheat plants in the conditions of soils contaminated with heavy metals and to increase its productivity was proved to be an effective agrobiotechnology.

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