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ASSESSMENT OF THE EFFECT OF THE NANOCHITOSAN PREPARATION ON SOIL AGROCHEMICAL INDICATORS

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Abstract
This article analyses the impact of using nanopreparations on the agrochemical properties of soil in saline areas based on scientific research. The study was conducted on irrigated meadow-alluvial soils of the Nukus district of the Republic of Karakalpakstan. The experiment was conducted using the "Nanochitosan" preparation for the Nukus-2 rice variety. According to the results, it was established that this preparation affects the agrochemical properties of the soil, including the content of humus, nitrogen, total and mobile phosphorus, potassium, carbonate, and gypsum.

Keywords: Saline soils, agrochemical properties, nanochitosan, nanopreparation, meadow-alluvial soils.

Introduction

Currently, as a result of climate change and a sharp rise in temperature, the emergence of drought is causing an increase in the area of saline soils. 85% of the Earth's surface is occupied by saline soils, of which more than 424 million hectares constitute the arable layer of the soil, and 833 million hectares are observed in the sub-arable layers [7].

As a result of soil salinisation, its properties are negatively affected, leading to a decrease in the yield and quality of agricultural crops. Soils with varying degrees of salinity are widespread in the Aral Sea region; currently, many scientists are conducting scientific research on the disruption of the ecological state and salinity of soils in the Aral Sea region. Scientific research shows that nanopreparations play an important role in stimulating plant growth and development, improving the soil microbiological environment, and enhancing the absorption of nutrients. These preparations affect not only plant physiology but also the activity of beneficial microorganisms in the soil.

Literature review

M.A. Pankov, U. Norkulov, G. Parpiev, R. Kurvontoev, A. Jumamuratov, A.T. Turdaliev, and Sh.M. Turdimetov conducted extensive scientific research on the study of the morphological, agrochemical, agrophysical, reclamation properties, mineralogical, and morphological composition of the region's soils [1].

Employees of the Institute of Soil Science and Agrochemistry conducted an in-depth study of the lower reaches of the Amudarya, as well as the lands of Khorezm and Karakalpakstan, and reached

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scientific conclusions regarding the genesis, evolution, agrochemical and agrophysical properties, and reclamation conditions of the soils [5].

B.S.Mambetnazarov conducted comprehensive research on the meadow-alluvial irrigated soils of the Republic of Karakalpakstan and explained in his research results that they are not rich in humus and other nutrients, and the content of nitrate nitrogen, mobile phosphorus, and exchangeable potassium decreases by the end of the growing season, which is a result of the absorption of nutrients by plants during the growing season [3].

L.A. Gafurova comprehensively studied the agrochemical and agrophysical properties of the soils of the Aral Sea region for many years and determined that at optimal values, the morphogenetic, agrochemical, agrophysical, and biological activity of these soils and the development of microorganisms in them depend on soil humus, pH, and mechanical composition; the intensity of "breathing" and enzyme activity is relatively high in non-saline and slightly saline irrigated soils; as salinity increases to medium and high levels, their activity drops to a minimum, and the nature of the seasonal dynamics of biological activity reaches its peak in spring, gradually decreases in summer, and slightly increases in autumn [2].

The preparation "Nanochitosan" contains 0.5% of a biologically active substance and is a naturally occurring nanostructured polysaccharide. This substance is a chitosan derivative characterised by the presence of biologically active ascorbic acid. Nanochitosan effectively acts against pathogenic microorganisms in plants. Its antimicrobial properties play an important role in plant protection by limiting the development of pathogenic microflora. At the same time, this preparation possesses properties that accelerate the plant growth process and increase its immune activity [7].

The research results show that nanochitosan also has a positive effect on the soil microbiological environment. In particular, it creates favourable living conditions for beneficial microorganisms and increases their activity. As a result, soil fertility improves and the stability of the agro-ecosystem is ensured [6,7,8].

Methodology

The following variants were studied in the experiment: Control (no nanopreparation used), Nanochitosan 1 was applied at 2700 ml/ha, and Nanochitosan 2 at 3000 ml/ha.

In the studies, soil analysis was conducted according to E.V. Arinushkina's "Manual for Chemical Soil Analysis" [4], soil humus content according to the I.V. Tyurin method; total nitrogen according to the Keldal method; total phosphorus and potassium according to the Mesheryakov method in a single sample; mobile phosphorus and exchangeable potassium according to the Machigin-Protasov method; SO_4 through gypsum - 0.1n Cl suction; CO_2 carbonates were analysed using the acidimetric method.

Analysis and key findings.

We analysed the effect of bio- and nanopreparations on the nutrients of the irrigated meadow-alluvial soils of the experimental field. As a result, in the control variant, the humus content was 0.35-0.97%, Nanochitosan 1 was 0.40-0.98%, and Nanochitosan 2 was 0.40-0.98%. In terms of humus, the nanopreparation indicators were higher than those of the control. Consequently, the nanopreparation applied over 3 years also affected the amount of soil nutrients.

In the control variant of the experiment, the total nitrogen content was 0.022-0.085%, phosphorus

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0.08-0.18%, and potassium 1.10-1.76%, whereas in the variants using nanopreparations, the total nitrogen content was 0.026-0.095%, and the total phosphorus was 0.10-0.21%, and the total potassium was 1.2-2.0%, respectively.

Table 1. Changes in the agrochemical properties of irrigated meadow-alluvial soils depending on the types and rates of bio- and nanopreparations

Depth of layer, cm	Humus, %	Total, %			Active, mg/kg		CO_2 carbonates,%	SO_4 Gypsum, %
		N	P	K	P_2O_5	K_2O		
Control								
0-30	0,97	0,085	0,18	1,76	16,5	140	8,8	0,356
30-50	0,47	0,046	0,13	1,26	12,6	120	8,6	0,268
50-70	0,35	0,022	0,08	1,10	7,6	90	9,2	0,229
Nanochitosan 1								
0-30	0,98	0,095	0,21	2,00	19,2	170	8,1	0,325
30-50	0,59	0,050	0,15	1,45	11,0	125	8,4	0,262
50-70	0,40	0,026	0,10	1,12	8,5	105	8,7	0,190
Nanochitosan 2								
0-30	0,98	0,092	0,19	1,84	17,8	155	8,3	0,344
30-50	0,60	0,066	0,17	1,52	16,5	120	8,5	0,252
50-70	0,40	0,032	0,10	1,30	9,0	100	8,8	0,205

Regarding mobile forms of nutrients: in the control variant, the phosphorus content was 7.6–16.5 mg/kg, and the potassium content was 90–140 mg/kg; in the variants using nanopreparations, the phosphorus content was 8.5–12.2 mg/kg, and the potassium content was 100–170 mg/kg.
Regarding the content of carbonates and gypsum, there is no significant difference between the control and the variants using nanopreparations.

Conclusion

In conclusion, the results of the conducted research showed that the increase in humus content in the soil is directly dependent on the type and chemical composition of the nanopreparations used. Observations conducted over three years confirmed that various nanopreparations exerted varying degrees of influence on the process of soil enrichment with organic matter. In particular, nanopreparations with biologically active components accelerated the formation of humus and significantly improved the agrochemical properties of the soil.
Furthermore, during the study, it was established that changes in the content of the main nutrients—nitrogen, phosphorus, and potassium—depend primarily on the amount and concentration of the nanopreparations used. The use of nanopreparations in normal and optimal doses ensures the accumulation of these elements in the soil and increases the efficiency of their absorption by plants.
Positive changes were observed when comparing the results obtained in all experimental variants with the control variant. In particular, the amount of humus and the concentration of nutrients increased significantly, which confirms the important role of nanopreparations in increasing soil fertility.
Overall, the results obtained show that the application of nanopreparations in agriculture is an effective tool for improving the biological and agrochemical properties of soils, increasing fertility, and forming a sustainable agro-ecosystem.

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