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# THE EFFECT OF MINERAL, ORGANIC FERTILIZERS AND BIOLOGICAL PREPARATIONS ON WHITE CABBAGE YIELD ON IRRIGATED GRAY SOILS

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## Abstract
This article investigates the combined effects of mineral and organic fertilizers, along with the biological preparation “Baikal EM-1”, on the yield and quality of white cabbage (Brassica oleracea) cultivated on irrigated typical grey soils in the Tashkent region. The study presents scientific data on the optimal rates and application periods of local, mineral, and biological fertilizers used for medium-late white cabbage grown under conditions of typical grey soils affected by irrigation-induced erosion.

**Keywords:** Irrigation erosion, typical grey soils, biopreparation, mineral and local fertilizers, application rates and timing, medium-late white cabbage, average yield, additional yield

## Introduction
As the global population continues to grow, imbalances and shortages in food production pose serious threats to human health and sustainable agriculture. In response, the need for efficient use of arable land, and the effective application of organic and mineral fertilizers, as well as biological preparations, is becoming increasingly important for boosting vegetable production. Globally, cabbage ranks among the most widely cultivated vegetables, with over 71.0 million tons produced annually. Nearly half of this global production takes place in China, followed by India, Russia, South Korea, Ukraine, Indonesia, Japan, Poland, and the United States. Overall, cabbage is cultivated in more than 150 countries worldwide.[1]

In areas affected by irrigation-induced erosion, there is a growing body of research focused on improving vegetable crop management, determining the nutrient requirements for crops, and using local and mineral fertilizers along with biological preparations. These efforts aim to preserve and enhance soil fertility, improve agro-physical and agro-chemical soil properties, and support ecosystem sustainability. Particularly in irrigated grey soil regions of Uzbekistan, improper irrigation practices and nutrient depletion have led to soil degradation. Restoring soil fertility and ensuring high crop productivity in these areas requires innovative approaches. Recent studies indicate that the combined use of mineral and organic fertilizers with biological preparations significantly improves the physical-chemical and microbiological

[1] https://worldmapper.org/maps/cabbage-production/



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properties of soil. Among such biological preparations, “Baikal EM-1” plays a critical role in converting soil nutrients into forms that are more accessible to plants, while also enhancing microbial activity. However, the combined effects of these inputs on white cabbage production, especially under erosion-affected conditions, have not been adequately studied. This research seeks to address this gap by evaluating the impact of mineral and organic fertilizers, along with the biological preparation Baikal EM-1, on the growth, nutrient uptake, and yield of white cabbage grown in the typical grey soils of the Tashkent region.

## Research Methods

Field experiments were conducted during the period of 2021–2023 at the central experimental farm of the Scientific Research Institute of Vegetable, Melon Crops and Potato of Uzbekistan. The site is located on traditionally irrigated typical grey soils affected by irrigation-induced erosion, with a slope gradient of 1.50%. The aim of the study was to determine the optimal rates and timing for the application of biological preparations, local organic, and mineral fertilizers to ensure high and quality yields of medium-late white cabbage under these soil conditions. The experiment consisted of 9 treatment variants arranged in three replications. The field trials were carried out following the methodological guidelines of the Uzbek Research Institute of Vegetable Growing [1; p. 180], as well as the methods described in "Methodology for Conducting Experiments in Vegetable, Melon and Potato Crops" by B.J. Azimov and B.B. Azimov [2; pp. 9–11], and "Methodology of Experimental Work in Vegetable and Melon Cultivation" by V.F. Belik [3; pp. 30–45]. The experimental design is presented in Table 1.

**Table 1. Experimental Design (2021–2023)**

| № | Annual Fertilizer Rates (kg/ha; t/ha; l/ha) | Fertilizer application during the vegetation period, kg/ha; t/ha; l/ha | | | |
|---|---|---|---|---|---|
| | | Before plowing | Before planting | First fertilization at seedling establishment stage | Second fertilization at the beginning of head formation |
| 1 | No fertilizer – Absolute control | - | - | - | - |
| 2 | Manure – 20 t/ha | 20 t/ga | - | - | - |
| 3 | Biopreparation – 30 l/ha | 10 l/ha | 10 l/ha | 5 l/ha | 5 l/ha – |
| 4 | Biopreparation – 30 l/ha + Manure – 20 t/ha | 10 l/ha +20 t/ga | 10 l/ha | 5 l/ha - | 5 l/ha – |
| 5 | Biopreparation – 30 l/ha + P – 150, K – 100 | 10 l/ha+ P-105, K-50 | 10 l/ha +P-45 | 5 l/ha - | 5 l/ha +K-50 |
| 6 | N – 150, P – 150, K – 100 | P-105, K-50 | N-50, P-45 | N-50 | N-50, K-50 |
| 7 | N – 200, P – 150, K – 100 | P-105, K-50 | N-50, P-45 | N-75 | N-75, K-50 |
| 8 | Biopreparation – 30 l/ha + N – 150, P – 150, K – 100 | 10 l/ha +P-105, K-50 | 10 l/ha, N-50, P-45 | 5 l/ha +N-50 | 5 l/ha + N-50, K-50 |
| 9 | Biopreparation – 60 l/ha + N – 150, P – 150, K – 100 | 20 l/ha +P-105, K-50 | 20 l/ha, N-50, P-45 | 10 l/ha +N-50 | 10 l/ha +N-50, K-50 |



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## Literature Review

The use of environmentally friendly preparations and naturally occurring physiologically active substances at appropriate rates and application times can enhance nutrient uptake from the soil, protect plants from phytopathogens and pests, alleviate stress conditions, and boost plant immunity—ultimately resulting in higher and better-quality yields.[2]

According to V.A. Koltunov, A.S. Bolotskikh, and others [4; p. 34], in the soil conditions of Ukraine, applying annual doses of 90 kg/ha of nitrogen, 90 kg/ha of phosphorus, and 90 kg/ha of potassium mineral fertilizers led to a white cabbage yield of 70 t/ha. However, when the rates of mineral fertilizers were slightly increased, the yield decreased to 64 t/ha, indicating the importance of balanced nutrient application.

S.F. Timofeyeva [5; pp. 55–61] recommended two top-dressings of white cabbage during the growing season: the first with N-30–40 kg/ha, P-80–100 kg/ha, and K-40–50 kg/ha, and the second with N-60–80 kg/ha, P-50–80 kg/ha, and K-80–100 kg/ha. Meanwhile, V.I. Zuyev, B.J. Azimov, and Kh. Umarov [6; pp. 52–54] advised applying 20–25 t/ha of manure, 250–350 kg/ha of superphosphate, and 150–200 kg/ha of potassium salt before plowing. Before transplanting cabbage seedlings, they recommended 120–150 kg/ha of superphosphate, followed by top-dressing during the growth period with 90–120 kg/ha of ammonium nitrate and 150–300 kg/ha of superphosphate during the first feeding, and 100 kg/ha of ammonium nitrate during the second feeding.

The use of organic fertilizers in vegetable cultivation improves the agro-physical and agrochemical properties of the soil and can increase crop yields by 15–27%. When using mineral fertilizers, it is necessary to consider not only the type of vegetable crops but also the degree to which the cultivation technology is intensive. In irrigated agricultural systems on sod-podzolic soils, the application rate of mineral fertilizers for vegetable crops (excluding cabbage) should not exceed N–90 kg/ha, P–90 kg/ha, and K–90 kg/ha. To improve the productivity of vegetable crops, humus-based fertilizers and microelements in the form of biological agents should be used more widely.[3]

When white cabbage is fertilized with simple and compound mineral fertilizers, its yield increases by 45–66%, and when manure is applied in combination with mineral fertilizers, the yield increase reaches 68–86%. It has been shown that the use of an organo-mineral fertilizer system enhances nitrogen and potassium uptake by cabbage plants and slightly improves phosphorus uptake as well. As a result, this has a positive effect on the growth and development of cabbage, creating favorable conditions for obtaining high and high-quality yields.[4]

[2] file:///C:/Users/ALFATECH.UZ/Downloads/125-244-1-SM.pdf
[3] file:///C:/Users/ALFATECH.UZ/Downloads/osnovnye-puti-sovershenstvovaniya-sistem-udobreniya-v-ovoschevodstve%20(1).pdf
[4] file:///C:/Users/ALFATECH.UZ/Downloads/427-839-1-SM.pdf



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## Research Results

Data on white cabbage yield obtained over three years during 2021–2023 are presented in Table 2.

In Variant 1 (control), where no fertilizers were applied, cabbage yields were 30.1 t/ha, 32.4 t/ha, and 28.7 t/ha for the respective years, with an average of 30.4 t/ha. This situation is considered to be the result of the nutrient reserves present in the soil.

In Variant 2, where 20 tons per hectare of organic fertilizer was applied, and in Variant 3, where 30 liters of Baikal EM-1 biological preparation was used, the cabbage yields by years were respectively 36.7 t/ha, 38.9 t/ha, 34.5 t/ha, and the average yield was 36.7 t/ha; and 35.6 t/ha, 36.1 t/ha, 33.6 t/ha, with an average of 35.1 t/ha. Compared to the control variant, the use of organic fertilizer and Baikal EM-1 biological preparation resulted in additional yields of 6.6 t/ha, 6.4 t/ha, 5.8 t/ha, and an average of 6.3 t/ha; and 5.5 t/ha, 3.7 t/ha, 4.9 t/ha, with an average of 4.7 t/ha, respectively.

In the 4th variant, where 20 tons per hectare of organic fertilizer and 30 liters of Baykal EM-1 biopreparation were applied to white cabbage, the yield for the respective years was 39.3 t/ha, 41.4 t/ha, and 37.2 t/ha, with an average of 39.3 t/ha. Compared to variant 2 (application of 20 t/ha of organic fertilizer) and variant 3 (application of 30 l/ha of Baykal EM-1 biopreparation), this represented a higher yield of 2.6 and 3.7 t/ha, 2.6 and 5.3 t/ha, 2.7 and 3.6 t/ha respectively by year, and an average increase of 2.6 and 4.2 t/ha over three years. It should also be noted that in the 5th variant, where Baykal EM-1 biopreparation was applied together with 150 kg/ha of phosphorus and 100 kg/ha of potassium mineral fertilizers, the average yield over three years was 41.4 t/ha, which is 11.0 t/ha higher than in the control variant. Thus, it was found that applying the Baykal EM-1 biopreparation in combination with organic or mineral fertilizers is more effective than applying it alone.

**Table 2 Effect of application rates and timing of biological preparations, organic and mineral fertilizers on the yield of white cabbage crop, t/ha**

| № | Annual Fertilizer Rates (kg/ha; t/ha; L/ha) | Years | | | Average yield, t/ha | Additional yield, t/ha |
|---|---|---|---|---|---|---|
| | | 2021 | 2022 | 2023 | | |
| 1 | No fertilizer – Absolute control | 30,1 | 32,4 | 28,7 | 30,4 | |
| 2 | Manure – 20 t/ha | 36,7 | 38,9 | 34,5 | 36,7 | 6,3 |
| 3 | Biopreparation – 30 L/ha | 35,6 | 36,1 | 33,6 | 35,1 | 4,7 |
| 4 | Biopreparation – 30 L/ha + Manure – 20 t/ha | 39,3 | 41,4 | 37,2 | 39,3 | 8,9 |
| 5 | Biopreparation – 30 L/ha + P – 150, K – 100 | 41,2 | 42,8 | 40,1 | 41,4 | 11,0 |
| 6 | N – 150, P – 150, K – 100 | 43,8 | 44,2 | 41,9 | 43,3 | 12,9 |
| 7 | N – 200, P – 150, K – 100 | 44,4 | 45,3 | 43,4 | 44,4 | 14,0 |
| 8 | Biopreparation – 30 L/ha + N – 150, P – 150, K – 100 | 48,1 | 50,1 | 47,8 | 48,7 | 18,3 |
| 9 | Biopreparation – 60 L/ha + N – 150, P – 150, K – 100 | 47,3 | 48,8 | 46,5 | 47,5 | 17,1 |



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In the 6th and 7th variants, where 150 kg/ha nitrogen, 150 kg/ha phosphorus, and 100 kg/ha potassium, and 200 kg/ha nitrogen, 150 kg/ha phosphorus, and 100 kg/ha potassium were applied respectively, the yields were 43.8 t/ha, 45.2 t/ha, 41.9 t/ha with an average of 43.6 t/ha, and 44.4 t/ha, 45.3 t/ha, 43.4 t/ha with an average of 44.4 t/ha respectively. The additional application of 50 kg/ha of nitrogen fertilizer resulted in an increased yield of 0.6 t/ha, 1.1 t/ha, and 1.6 t/ha respectively, with an average of 1.1 t/ha over three years.

Relatively optimal results were observed in the 8th variant, where Baykal EM-1 biopreparation at 30 l/ha and 150 kg/ha nitrogen, 150 kg/ha phosphorus, and 100 kg/ha potassium were applied. The yields in respective years were 48.1 t/ha, 50.1 t/ha, and 47.8 t/ha, with an average of 48.7 t/ha, which is 18.3 t/ha higher than the control variant. When compared to the 9th variant (Baykal EM-1 biopreparation at 60 l/ha and the same rates of mineral fertilizers), the yield differences were 0.8 t/ha, 1.3 t/ha, and 1.3 t/ha respectively by year, with an average difference of 1.1 t/ha over three years.

Therefore, it was concluded that it is more advantageous to apply Baykal EM-1 biopreparation at 30 l/ha together with mineral fertilizers, rather than increasing the rate to 60 l/ha.

## Conclusion

Field experiments conducted during 2021–2023 on typical gray soils affected by irrigation erosion showed that the application of the Baykal EM-1 biopreparation in combination with either organic or mineral fertilizers had a significant positive impact on the growth, development, and yield of white cabbage. The most effective treatment was the joint application of mineral fertilizers—150 kg/ha of nitrogen, 150 kg/ha of phosphorus, and 100 kg/ha of potassium—with 30 liters/ha of Baykal EM-1. This combination resulted in a considerable increase in yield compared to both the control and other treatment variants. Thus, it is recommended to apply Baykal EM-1 in combination with mineral fertilizers rather than alone or in higher doses, as it leads to improved cabbage productivity under the studied soil and climate conditions.

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