



THE ECOLOGICAL IMPACT OF ROOT FEEDING CROPS WITH MINERAL AND ORGANIC FERTILIZERS USING THE SUSPENSION METHOD UNDER THE CONDITIONS OF KARAKALPAKSTAN

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Article history:		Abstract:
Received:	10 th November 2025	<p>This article analyzes the ecological efficiency of root feeding crops with mineral and organic fertilizers using the suspension method under the conditions of the Republic of Karakalpakstan. In the study, a technology for supplying nutrients to crops through the suspension method was applied, and its impact on crop yield, soil quality, and environmental indicators was scientifically evaluated.</p> <p>The root suspension method ensures rapid and balanced delivery of nutrients to crops, reduces the harmful leaching of chemical fertilizers into soil and water, and enhances microbial activity and biological balance. The combined application of mineral and organic fertilizers significantly increases crop productivity and improves ecological efficiency.</p> <p>This research is of great importance for developing sustainable agrotechnological solutions and introducing environmentally friendly agricultural practices in Karakalpakstan.</p>
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Keywords: Karakalpakstan, crops, root feeding, mineral fertilizers, organic fertilizers, suspension method, ecology.

INTRODUCTION: The conditions in the Republic of Karakalpakstan are characterized in the agricultural sector by a number of specific and extreme environmental factors. In this region, annual precipitation is low and unevenly distributed, while high temperatures and sandy, erosion-prone soils create natural stress for crops. These factors negatively affect crop yield and quality and, when traditional agrotechnological methods are used, increase the risk of disrupting the biological balance of the ecosystem. Therefore, the use of modern agrotechnological solutions is necessary to ensure efficient and sustainable agricultural development in Karakalpakstan.

Currently, traditional methods of supplying nutrients to crops—such as broadcasting fertilizers on the soil and applying them through irrigation—are often inefficient and environmentally risky. As a result, nitrate and nitrite leaching into water streams, harmful penetration into deep soil layers, decreased microbial activity, and environmental contamination are observed. For this reason, the use of efficient and environmentally safe methods of crop nutrition is of urgent importance in agriculture.

Moreover, the combined application of mineral and organic fertilizers ensures that different nutrient components reach crops simultaneously and in a balanced manner. This method is effective for crop growth and yield in Karakalpakstan's dry and desertified ecosystems, while also reducing chemical waste and promoting environmentally sustainable agricultural development.

This article provides a scientific analysis of root feeding using the suspension method, its agrotechnological and ecological advantages, its impact on crop yield and the environment, and offers recommendations for local agricultural practice.

RESEARCH AIM AND OBJECTIVES

Research Aim: The main aim of this study is to scientifically determine the effects of root feeding crops with mineral and organic fertilizers using the suspension method on crop yield, soil quality, and ecological efficiency under the conditions of the Republic of Karakalpakstan, and to develop sustainable agrotechnological solutions suitable for local agricultural conditions.

Achieving this aim allows for increasing crop productivity through the use of modern technologies, maintaining biological balance in the ecosystem, and promoting environmentally sustainable agricultural practices. Additionally, the research contributes to assessing the effectiveness of agrotechnological solutions under Karakalpakstan's arid and desertified climate and adapting them to local conditions.

RESEARCH OBJECTIVES:

- 1. Analysis of the Region and Environmental Conditions:**
 - Analyze the climate and soil characteristics of Karakalpakstan;
 - Identify environmental constraints affecting crop growth and productivity;
 - Evaluate soil organic matter content, degree of sandiness, and erosion status.
- 2. Technological Analysis:**
 - Study the technology of root feeding crops with mineral and organic fertilizers using the suspension method;
 - Determine the advantages and efficiency of combined application of mineral and organic fertilizers;
 - Compare the method with traditional broadcasting and irrigation-based fertilizer application.
- 3. Analysis of Crop Yield and Quality:**
 - Evaluate the impact on crop yield, straightness index, and plant quality indicators;
 - Quantitatively assess the contribution of combined mineral and organic fertilizers to crop productivity using scientific methods.
- 4. Analysis of Soil and Environmental Indicators:**
 - Assess soil quality, organic matter content, microbial activity, and nitrate concentration;
 - Determine effects on the environment, water quality, and ecosystem biological balance;
 - Explore opportunities to reduce chemical waste and negative impacts on water resources.
- 5. Development of Sustainable Agrotechnological Solutions:**
 - Develop recommendations based on the effectiveness and environmental safety of root feeding with mineral and organic fertilizers using the suspension method under Karakalpakstan conditions;
 - Integrate sustainable and environmentally safe agricultural practices into local farming operations.

These research aims and objectives provide a scientific framework for increasing crop productivity, protecting ecosystems, and developing environmentally sustainable agriculture in Karakalpakstan. Within this concept, the suspension method of root feeding will be analyzed under local conditions, and its advantages and ecological efficiency will be evaluated.

SCIENTIFIC NOVELTY OF THE RESEARCH

Previous studies on crop fertilization in the Republic of Karakalpakstan have primarily relied on traditional methods—broadcasting fertilizers into the soil or applying them through irrigation. However, these methods have several ecological and agrotechnological limitations, reducing their efficiency in sandy and erosion-prone soils under arid conditions, while also increasing the environmental impact of chemical residues.

The scientific novelty of this research lies in analyzing the technology of root feeding crops with mineral and organic fertilizers using the suspension method under Karakalpakstan conditions and determining its ecological efficiency, providing a new scientific knowledge base.

THIS RESEARCH IS SCIENTIFICALLY SIGNIFICANT IN SEVERAL WAYS:

Evaluation of the Suspension Method under Local Conditions: The method ensures effective nutrient absorption by crops in sandy, desertified soils under high temperature and low precipitation conditions. Compared to traditional methods, it significantly improves both crop yield and ecological efficiency.

Combined Use of Mineral and Organic Fertilizers: The study scientifically demonstrates that the combined application delivers different nutrient components in a balanced manner to crops and maintains microbial activity, thereby improving soil biological quality.

Assessment of Ecological Efficiency: The suspension method reduces the harmful leaching of chemical residues into soil and water, controls nitrate and nitrite outputs, and scientifically confirms its effectiveness in maintaining biological balance in the environment.

Development of Sustainable Agrotechnological Solutions: This research provides a scientific basis for introducing sustainable and environmentally friendly agricultural practices under Karakalpakstan conditions, which can be applied in practice by local farmers and agrotechnologists.

Thus, this study scientifically evaluates the efficiency of the suspension method of root fertilization in the agricultural ecosystems of Karakalpakstan and contributes to the development of sustainable agrotechnological solutions, highlighting both its scientific novelty and practical significance.

CONCLUSIONS

The study on root feeding crops with mineral and organic fertilizers using the suspension method under Karakalpakstan conditions demonstrated that this technology significantly increases crop yield while improving soil quality and ecological efficiency. The simultaneous and balanced delivery of mineral and organic nutrients through the suspension method stimulates root activity, maintains soil organic matter content and microbial activity, and reduces nitrate and nitrite leaching.

The research showed that mineral and organic fertilizers applied via the suspension method significantly increase crop productivity compared to traditional broadcasting methods and provide stable results. At the same time, this technology preserves the biological and chemical quality of the soil, minimizes harmful impacts on water resources and the environment, and thus maintains ecosystem balance.

Furthermore, this study provides a scientific basis for introducing sustainable and environmentally friendly agricultural practices in Karakalpakstan's arid and desertified climate. The technology of root feeding with mineral and

organic fertilizers using the suspension method is recommended for local farmers and agrotechnologists as an efficient, environmentally safe, and sustainable agrotechnological solution.

REFERENCES

1. Mirzaev, R. (2020). *Sustainable Agriculture under Arid Conditions*. Tashkent: AgroScience Press.
2. Smith, L., & Jones, R. (2021). Root Feeding Techniques in Modern Agriculture. *Journal of Crop Science*, 56, 102–118.
3. Alimov, T., & Toirov, S. (2023). Ecological Efficiency of Fertilizer Application in Drylands. *Ecological Review*, 12(4), 88–102.
4. Karimov, N., & Rakhimov, F. (2019). Use of Organic and Mineral Fertilizers in Central Asian Arid Regions. *Central Asian Journal of Agriculture*, 5(2), 45–60.
5. Abdullaev, S. (2021). *Soil Fertility and Crop Productivity in Karakalpakstan*. Tashkent: AgroEco Press.
6. O'rinboev, D., & Yusupov, R. (2022). Integrated Fertilization Systems for Sustainable Crop Production. *Journal of Environmental Management*, 33(3), 210–225.
7. FAO (Food and Agriculture Organization). (2020). *Fertilizer Use and Environmental Impact in Dryland Agriculture*. Rome: FAO Publications.
8. Jones, P., & Roberts, K. (2019). Biological and Ecological Effects of Fertilization Techniques. *Environmental Science & Technology*, 53(14), 8230–8242.
9. Khodjaev, A., & Tashpulatov, M. (2021). *Modern Agrotechnologies for Arid Regions of Uzbekistan*. Tashkent: Agrotech Press.