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THE EFFECT OF FUJIMIN LIQUID FERTILIZER ON INCREASING SOIL FERTILITY UNDER EXTREME CLIMATIC CONDITIONS

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ABSTRACT

This study evaluated the effects of Fujimin, a fulvic-acid-based liquid organic fertilizer, on the fertility of irrigated takyr-meadow soils under the extreme soil and climatic conditions of the Surkhandarya Region, Uzbekistan. Field treatments compared a conventional mineral fertilizer regime with a 20% reduction in mineral fertilizer and several liquid organic fertilizer treatments, including Fujimin at 4 and 5 L/ha. Changes in humus and mobile nitrogen, phosphorus, and potassium were assessed in the 0-30 and 30-50 cm soil layers. The 5 L/ha Fujimin treatment produced the largest annual increase in humus among the tested treatments, with gains of 0.0825% in the 0-30 cm layer and 0.067% in the 30-50 cm layer. In the surface layer, nitrate nitrogen reached 24.5 mg/kg and labile phosphorus reached 26.8 mg/kg, representing increases of 11.6 and 10.0 mg/kg, respectively. Mobile potassium also increased relative to the reduced-mineral-fertilizer baseline. The results indicate that applying Fujimin at 4-5 L/ha together with a 20% reduction in mineral fertilizer can improve soil nutrient status and help maintain soil fertility under high-temperature, drought-prone, and saline conditions. These findings support the use of fulvic-acid-based inputs as a resource-conserving component of cotton production in environmentally stressful regions.

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Keywords: *Fujimin, fulvic acid, takyr-meadow soil, soil fertility, salinity, cotton.*

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Introduction

In Uzbekistan, the rational use of agricultural land, environmental sustainability, and improvement of soil fertility are priority policy areas. Presidential Resolution No. PQ-71 of February 13, 2024, and Cabinet of Ministers Resolution No. 97 of February 20, 2024, establish measures to combat agricultural land degradation, increase soil humus content, and improve soil fertility, including the use of Fujimin technology in demonstration areas (Cabinet of Ministers of the Republic of Uzbekistan, 2024; President of the Republic of Uzbekistan, 2024). These priorities emphasize the prevention of dehumification and degradation, the enrichment of soil organic matter, and the development of mechanisms for increasing soil fertility and crop yields. Accordingly, this study assesses changes in the properties of irrigated takyr-meadow soils under extreme soil and climatic conditions.

Fujimin is a liquid organic fertilizer based on fulvic acid. According to the product information, the concentrate is diluted with water and applied by spraying, and its proposed advantage is the chelation of nutrients that can facilitate plant uptake of nitrogen, phosphorus, potassium, iron, magnesium, and other elements (AgroBio, n.d.).

Organic liquid fertilizers can influence soil organic matter and the availability of nitrogen, phosphorus, and potassium, all of which are important for crop nutrition and development. Research on humic and fulvic substances has examined their composition, soil functions, and interactions with plant nutrition (AgroBio, n.d.; Boynazarov et al., 2023; Kononova, 1984; Orlov, 1990, 1997; Orlov et al., 1996; Preston, 1996; Tyurin, 1965; Wilson, 1987).

The Surkhandarya Region is characterized by very hot and dry conditions. In Termez, high land-surface temperatures occur during summer, and in the Djarkurgan District the hot southwesterly garm-sil (Afghan wind) can intensify heat and moisture stress in irrigated cropping systems. The study area is also affected by salt accumulation, so drought, heat, and salinity may act together as constraints on plant growth and soil functioning.

Foundational research on soil organic matter has established its importance for soil fertility and for the physical and chemical properties that regulate nutrient availability. Relevant work includes studies of soil organic matter, plant nutrition and soil formation, and nuclear magnetic resonance approaches to soil organic matter characterization (Kononova, 1984; Ponomareva, 1972; Preston, 1996; Tyurin, 1965; Wilson, 1987).

Research Methods

Soil investigations used genetic-geographical, lithological-geomorphological, chemical-analytical, profile, field, desktop, and cartographic methods. The procedures followed established soil-survey and analytical guidance used in Uzbekistan and standard chemical analysis methods (Arinushkina, 1970; Qo'ziev et al., 2013; UzPITI, 1963).

Research Objective

The objective was to increase plant resistance to climate-related stress and improve soil fertility through the use of Fujimin liquid fertilizer based on fulvic acid.

Results and Discussion

Soil fertility depends strongly on humus and nutrient availability, and loss of soil moisture can accelerate deterioration of these components and constrain crop growth. In 2023, fine-staple cotton was grown in the Djarkurgan, Angor, Sherabad, and Termez districts of the Surkhandarya Region over an area of approximately 60,000 ha despite extreme soil and climatic conditions. During field monitoring in Sherabad District, a soil-surface temperature of 68°C was observed during the flowering and budding periods.

Liquid organic fertilizers can improve soil structure and water retention. The investigated soils are affected primarily by sulfate and chloride-sulfate salinization. As salt concentration increases, osmotic pressure in the soil solution rises and can restrict root water uptake and plant growth. In this experiment, Fujimin and humate-based treatments were evaluated as approaches for mitigating these stress factors. Biofertilizer use is also consistent with regional resource-efficient cotton production recommendations for extreme climatic conditions (Tadjiyev et al., 2017, 2022).

Table 1

Experimental Design

Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
N200P140K100 Ratio 1:0.7:0.5 - control	N160P112K80 Ratio 1:0.7:0.5 Ground, mineral fertilizers have been reduced by 20 percent	Ground + 10 L/ha liquid potassium humate fertilizer	Ground + 5 L/ha Entogumin	Ground + 5 L/ha Gumimax -R	Ground + 4 L/ha Fujiminbio fertilizer	Ground + 5 L/ha Fujiminbio fertilizer	Microbiological preparation

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Table 2

Preliminary Analysis Results for Takyr-Meadow Soils Prior to Land Leveling

No.	Depth (cm)	Humus (%)	N-NO3	P2O5	K2O	CO2 (%)	pH	EC2
2K	0-34	0.844	16.40	19.8	105	8.10	7.55	0.73
2K	34-52	0.798	9.72	18.0	84	9.06	7.66	0.54
2K	52-84	0.757	7.87	15.0	64	10.17	7.81	0.37
2K	84-115	0.687	5.03	10.2	45	10.61	7.79	0.23
2K	115-150	0.507	2.80	6.4	41	10.99	7.88	0.22

The analyses demonstrated changes in nutrient and humus content in the topsoil (0-30 cm) and subsoil (30-50 cm) of the irrigated takyr-meadow soils (Table 3).

In the control (Option 1), humus content in the 0-30 cm layer was 1.209%, whereas in the reduced-mineral-fertilizer treatment (Option 2) it was 1.095%. Treatments receiving liquid organic fertilizers showed positive changes. In Option 7 (reduced mineral fertilizer + 5 L/ha Fujimin), the annual increase in humus was 0.0825% in the 0-30 cm layer and 0.067% in the 30-50 cm layer, indicating a favorable response of soil organic matter.

Mobile nitrogen was also responsive to treatment. In the control, N-NO3 content in the 0-30 cm layer was 11.5 mg/kg. In Options 6 and 7, which received 4 and 5 L/ha Fujimin, respectively, mobile nitrogen reached 23.9 and 24.5 mg/kg, with annual increases of 9.8 and 11.6 mg/kg, respectively.

Phosphorus and potassium availability also changed across treatments. Labile P2O5 in the 0-30 cm layer was 17.8 mg/kg in the control and 26.8 mg/kg in Option 7, an annual increase of 10.0 mg/kg. Mobile K2O reached 211 mg/kg in Option 3 (potassium humate) and 148 mg/kg in Option 7, corresponding to increases of 94.0 and 57.0 mg/kg, respectively. Nutrient stocks were comparatively more stable in the 30-50 cm layer (Table 3).

Table 3

Difference in Nutrient Content Throughout the Year

Option	Depth (cm)	Humus (%)	Annual difference (+)	Mobile nutrients (mg/kg)					
				N-NO3	Annual difference (+)	P2O5	Annual difference (+)	K2O	Annual difference (+)
B-1	0-30	1.209	0.0045	11.5	0.7	17.8	2.2	188	20.0
B-1	30-50	1.005	0.004	8	1.5	11	1.6	156	8.0
B-2	0-30	1.095	0.001	14	0.3	19.8	1.3	141	7.0
B-2	30-50	0.929	0.0005	10.5	0.7	13.4	0.8	124	4.0
B-3	0-30	1.055	0.0095	15.9	3.0	20.8	3.9	211	94.0
B-3	30-50	0.955	0.0075	9.5	1.9	13.6	3.4	182	84.0
B-4	0-30	1.089	0.0095	15.5	3.1	16.2	3.8	156	29.0
B-4	30-50	0.989	0.0495	8.9	2.6	14.2	4.8	135	27.0
B-5	0-30	0.85	0.0375	17.5	5.0	20.6	1.8	166	46.0
B-5	30-50	0.595	0.0275	13.5	3.8	14.8	1.6	125	24.0
B-6	0-30	1.123	0.0515	23.9	9.8	23.6	6.8	152	47.0
B-6	30-50	0.878	0.032	18.5	8.5	17.2	6.6	105	19.0
B-7	0-30	0.975	0.0825	24.5	11.6	26.8	10.0	148	57.0
B-7	30-50	0.844	0.067	18.5	9.0	18.4	7.0	115	34.0
B-8	0-30	0.920	0.054	18.5	7.6	19.8	4.0	205	38.0
B-8	30-50	0.804	0.0195	12.5	3.6	13.2	3.6	115	18.0

Conclusion

The findings show that applying Fujimin at 4-5 L/ha together with a 20% reduction in mineral fertilizer improved the measured agrochemical indicators and helped maintain soil fertility under extreme conditions.

Liquid organic fertilizers can serve as a resource-conserving tool in cotton production under climate-related stress. Fulvic-acid-based preparations are associated with nutrient chelation and may

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support nutrient availability and crop development; these functions are consistent with regional cotton-production recommendations and earlier work on organic amendments (Avliyokulov & Tadjiyev, 1992; Avliyokulov et al., 2008; Boltaev et al., 2008; Jurayev & Tojiyev, 1992; Rakhmatov et al., 2005; Tadjiyev et al., 2006).

Under the saline and high-temperature conditions observed in the study area, the Fujimin treatment was associated with improved nutrient status and favorable conditions for crop-component development. Integrated crop-protection and management recommendations for the Surkhandarya Region likewise emphasize the importance of managing multiple environmental and biological stresses (Khasanov et al., 2005).

Overall, integrating Fujimin into resource-conserving cotton production may contribute to maintaining soil fertility and reducing degradation risks under stressful environmental conditions. Recent work on soil degradation in Uzbekistan further underscores the importance of monitoring soil physical and chemical changes under changing hydrological and environmental conditions (Jabbarov et al., 2025).

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