



**THE EFFECT OF THE BIOPREPARATION ECOGUMIN AND MINERAL FERTILIZER RATES ON THE TAXONOMIC GROUPS OF SOIL MICROORGANISMS IN COTTON CULTIVATION UNDER TYPICAL GRAY SOIL CONDITIONS**

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**Abstract**

This study examines the effects of the biostimulant Ecogumin on the taxonomic structure of soil microbial communities in cotton fields cultivated on typical gray soils of the Tashkent region. The influence of Ecogumin was evaluated under varying application rates of local organic and mineral fertilizers. The experimental results indicated that the combined application of Ecogumin with mineral fertilizers significantly enhanced soil microbial activity, with the most pronounced positive effects observed at fertilizer rates of N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> supplemented with 1.0 and 1.5 t/ha of local organic fertilizers.

**Keywords:** Typical gray soil, Ecogumin preparation, meat-peptone agar, starch-ammonia medium, bacteria, actinomycetes, fungi.

**Аннотация**

Научная статья содержит информацию о влиянии препарата «Экогумин», применяемого к хлопчатнику в условиях типичных серых почв Ташкентской области, на таксономическую группу микроорганизмов в почве в зависимости от норм местных и минеральных удобрений. В эксперименте положительные





результаты были получены при вариантах применения «Экогумина» на фоне минеральных удобрений  $N_{200}P_{140}K_{100} + 1$  т/га;  $N_{200}P_{140}K_{100} + 1,5$  т/га. Ключевые слова: Типичная серая почва, препарат экогумина, мясо пептонный агар, крахмально-аммиачная среда, бактерии, актиномицеты, грибы.

## Introduction

The Government of Uzbekistan prioritizes the enhancement of agricultural productivity and soil fertility through the adoption of scientific innovations and advanced farming practices. Organic fertilizers improve soil physicochemical properties, enhance nutrient availability, and promote optimal crop growth and development. Their application in cotton cultivation increases yield and quality, maintains soil organic matter and humus balance, and stimulates beneficial microbial activity, thereby enhancing overall soil fertility.

In this context, developing scientifically based guidelines for the combined use of the organic fertilizer Ecogumin with mineral fertilizers is crucial. Understanding their effects on soil physicochemical characteristics and microbial activity is essential for optimizing nutrient availability and supporting sustainable cotton production. Soil microorganisms play a pivotal role in nutrient cycling, and their abundance and activity are influenced by soil structure, aeration, and fertilization practices. Therefore, studying the interactions between Ecogumin, mineral fertilizers, and soil microbial communities is a critical step toward improving soil fertility management and cotton productivity.

## Methods

The abundance and composition of microorganisms were determined according to Tepper's method, which allows for the quantification of different ecological and trophic groups, including bacteria, actinomycetes, and fungi. Selective media were used for each microbial group: meat-peptone agar for bacteria, starch-ammonia medium for actinomycetes, and other appropriate media for fungi. Microbial colonies were counted after incubation, and their density was expressed as colony-forming units (CFU) per gram of soil.

## Results

The results of the 2025 field experiment on cotton demonstrated a significant increase in soil bacterial abundance in treatments where the organic fertilizer Ecogumin was applied in combination with mineral fertilizers. Analysis of the data





indicated that on May 15, in the 0–30 cm soil layer, the treatments with Ecogumin applied at 1.0 t/ha and 1.5 t/ha on the background of mineral fertilizers (variants 8 and 9) exhibited bacterial counts of 43 and 45 million CFU/g, respectively. This represents an increase of 8–9 million CFU/g compared to treatments with the same doses of Ecogumin without mineral fertilizers (variants 3 and 4) and an increase of 16–19 million CFU/g relative to the treatment with only mineral fertilizers (N<sub>200</sub>P<sub>140</sub>K<sub>100</sub>, variant 6) (see Table 3.4.1).

Furthermore, in the treatment where 20 t/ha of manure was applied together with mineral fertilizers (variant 10), bacterial abundance in the 0–30 cm soil layer increased by 8.0 million CFU/g on May 15 compared to the treatment with only mineral fertilizers (variant 6). These results indicate a clear synergistic effect of combining Ecogumin and organic fertilizers with mineral fertilizers on soil bacterial populations.

Another key taxonomic group of soil microorganisms is fungi, which play an active role in the decomposition of organic residues. Fungal abundance was naturally higher in spring and autumn, with a marked increase observed toward the end of the cotton growing season. This pattern is likely associated with root exudates and organic residues present in the cotton rhizosphere. The application of mineral fertilizers was found to increase fungal abundance in the soil. However, in treatments combining Ecogumin with mineral fertilizers, the highest fungal populations were observed not at the end of the growing season, but rather during the mid-growing period, coinciding with flowering and fruit-setting stages. This effect is attributed to the improvement of soil physicochemical properties by Ecogumin.

The combined use of Ecogumin and mineral fertilizers also significantly increased the number of fungi growing on Chapek medium in typical gray soils compared to the control. This response is related to the high demand of fungi for both organic and mineral nutrients in the soil (Table 1). For example, on May 15, fungal counts in the control treatment were 38,000 CFU/g, while they reached 67,000 CFU/g in the 20 t/ha manure treatment, 62,000 CFU/g in the 200P<sub>140</sub>K<sub>100</sub> treatment, 67,000 CFU/g in the 1.0 t/ha Ecogumin treatment, and 78,000 CFU/g in the 1.5 t/ha Ecogumin treatment. In the combined treatments N<sub>200</sub>P<sub>140</sub>K<sub>100</sub>+ 1.0 t/ha Ecogumin, N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.5 t/ha Ecogumin, and N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 20 t/ha manure fungal abundance increased further to 88,000; 90,000; and 82,000 CFU/g, respectively. Notably, the application of Ecogumin at 1.0 and 1.5 t/ha on the background of mineral fertilizers (variants 8–9) resulted in a significant increase in fungal counts compared to the control and other treatments.



Actinomycetes constitute another important group of soil microorganisms. The abundance of actinomycetes growing on starch-ammonia agar was significantly influenced by both organic and mineral fertilizers. The highest actinomycete populations were observed in treatments where Ecogumin was applied at 1.0 and 1.5 t/ha in combination with mineral fertilizers. On May 15, actinomycete counts in the control treatment were 14 million CFU/g, while in the 20 t/ha manure treatment they reached 24 million CFU/g, and in the N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> treatment 22 million CFU/g. In treatments without mineral fertilizers but with Ecogumin applied at 1.0 and 1.5 t/ha, actinomycete abundance increased to 26 and 28 million CFU/g, respectively.

When Ecogumin was applied in combination with mineral fertilizers (N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.0 t/ha and N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.5 t/ha), actinomycete abundance increased by 28 and 30 million CFU/g relative to the control. Compared to treatments with only mineral fertilizers, manure, or Ecogumin applied separately, the actinomycete counts increased as follows: 20; 18; 16; and 14 million CFU/g in the 1.0 t/ha treatment, and 22; 20; 18; and 16 million CFU/g in the 1.5 t/ha treatment (Table 2).

By the peak of the cotton growing season, actinomycete populations increased across all treatments. On July 15, actinomycete abundance in the control treatment was 23 million CFU/g, 37 million CFU/g in the N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> treatment, 32 million CFU/g in the 20 t/ha manure treatment, and 40 and 42 million CFU/g in treatments with Ecogumin applied at 1.0 and 1.5 t/ha, respectively. In combined treatments, actinomycete abundance further increased, reaching 56; 57; and 52 million CFU/g in N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.0 t/ha Ecogumin, N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.5 t/ha Ecogumin, and N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 20 t/ha manure, respectively. Notably, in the treatments with mineral fertilizers combined with Ecogumin (N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.0 t/ha and N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.5 t/ha), actinomycete counts in the 0–30 cm soil layer reached 56 and 57 million CFU/g, which is 33 and 34 million CFU/g higher than the control (Table 2).





Table 1 Effect of Mineral and Organic Fertilizers on Soil Bacterial and Fungal Populations

№	Bacterial abundance, million CFU/g soil												Fungal abundance, thousand CFU/g soil											
	15.04		15.05		15.06		15.07		15.08		15.09		15.04		15.05		15.06		15.07		15.08		15.09	
	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50
1	12	5	14	10	27	12	29	15	22	14	25	16	28	8	38	13	43	18	48	18	43	13	38	13
2	30	20	45	32	54	34	56	35	50	37	60	40	50	26	65	30	67	32	70	34	67	32	55	28
3	35	22	48	33	54	37	58	42	52	39	62	40	50	28	67	32	67	32	70	37	67	32	56	30
4	37	27	50	37	54	40	52	39	51	39	60	40	67	36	78	35	77	37	77	42	67	37	62	32
5	32	20	38	25	42	28	47	30	47	30	52	32	62	32	67	32	67	32	67	32	62	27	57	27
6	23	15	40	25	42	26	50	27	45	27	50	27	42	22	62	27	62	27	60	30	57	27	52	24
7	37	25	45	35	53	39	50	38	50	35	57	39	67	36	77	35	75	37	74	42	67	34	62	32
8	50	35	56	45	68	47	75	48	65	55	77	48	75	45	88	57	92	49	94	50	84	47	75	40
9	53	39	59	50	70	47	78	50	65	58	79	51	75	45	90	47	94	52	97	52	87	47	77	42
10	45	28	46	40	57	44	64	45	59	44	66	45	72	42	82	42	85	42	87	45	77	42	70	37

Table 2 Effect of Mineral and Organic Fertilizers on Soil Actinomycete Populations

	Annual rate of mineral fertilizers, kg/ha			Manure, t/ha	Ecogumin, t/ha	Actinomycete abundance, million CFU/g soil													
	N	P	K			15.04		15.05		15.06		15.07		15.08		15.09			
						0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50	0-30	30-50		
1	-	-	-	-	-	9	6	14	7	19	10	23	12	16	7	19	9		
2	200	140	100		0,5	20	14	26	14	30	18	40	20	36	17	34	18		
3	200	140	100		1,5	22	14	26	16	32	18	42	24	40	17	37	20		
4					1,5	24	16	28	18	34	22	38	24	40	18	42	24		
5				20		17	12	24	14	27	17	32	17	32	14	37	17		
6	200	140	100			16	10	22	12	27	16	37	17	32	14	32	17		
7	200	140	100		0,5	35	17	36	24	42	26	52	32	57	37	52	30		
8	200	140	100		1,0	38	20	42	27	48	30	56	38	62	40	58	34		
9	200	140	100		1,5	42	22	44	28	50	32	57	40	64	42	60	36		
10	200	140	100	20		34	18	38	22	44	28	52	34	58	37	52	30		

### Conclusion

Laboratory experiments indicated that the lowest microbial abundance was observed in the control treatment without fertilizer application. Overall, the populations of all microbial groups increased throughout the cotton growing season, with only a slight decline observed in some groups toward the end of the growing period. This pattern is attributed to rising temperatures from early spring and optimal soil moisture maintained through irrigation.



Bacterial populations grown on meat-peptone agar also varied depending on the application of organic fertilizers. In treatments where Ecogumin was applied in combination with mineral fertilizers, bacterial and fungal abundance in the 0–30 cm soil layer continued to increase until the end of the growing season. This effect was particularly pronounced in treatments with mineral fertilizers combined with Ecogumin at 1.0 and 1.5 t/ha (N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.0 t/ha and N<sub>200</sub>P<sub>140</sub>K<sub>100</sub> + 1.5 t/ha), highlighting the synergistic effect of the combined application on soil microbial activity.

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