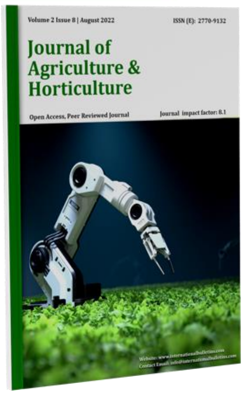

EFFECT OF APPLIED AGROTECHNOLOGIES ON THE ACTIVITY OF MICROORGANISMS

N.R.Safarova
D.A.Qodirova
B.Q.Safarov
Tashkent state agrarian university
https://doi.org/10.5281/zenodo.17098271

Abstract: In this scientific work, the influence of various agrotechnological measures on the activity of microorganisms was studied. In the studies, against the background of agrotechnical measures, the vital activity, number, and diversity of beneficial soil microorganisms - especially ammonifiers, actinomycetes, oligonitrophiles, micromycetes, phosphorus-decomposing bacteria, and free-living nitrogen-fixing bacteria - were analyzed. In particular, the influence of organic and mineral fertilizer application systems has been determined. The research results reveal the importance of microbiological factors in increasing soil fertility and recommend agrotechnologies that activate microorganisms to ensure the stability of the agroecosystem.

Keywords. No-till, microorganisms, agrotechnology, rockogumin, nanosilicon ammonifier, oligonitrophil, micromycete, actinomycete, phosphorus-degrading bacteria, soil fertility, organic matter, mineral fertilizers, microbiological activity

Introduction

One of the main factors ensuring soil fertility is its microbiological activity. Ammonifiers, oligonitrophiles, micromycetes, and actinomycetes play a crucial role in maintaining soil fertility and ecological stability. These microorganisms participate in the circulation of organic matter in the soil, mineralization of nutrients, humus formation, and preservation of the soil's phytosanitary condition. They are sensitive to agronomic practices, fertilizer types, and soil tillage, and studying the ecophysiological characteristics, biological roles, and ecosystem functions of each group is of great importance for modern agroecological approaches.

Studies on the microbiological activity of soils in Uzbekistan have been conducted by D.A. Qodirova [2], G.M. Nabiyeva [3], and others. The process of soil formation and its fertility increase are directly linked to microorganisms. The main part of organic matter entering the soil is formed by plant roots, and their decomposition produces humus. The role of microorganisms in this process is immense. Bacteria, actinomycetes, and fungi decompose complex organic compounds in the soil into relatively simple compounds. At the same time, organic acids produced by bacteria and fungi interact with mineral compounds in the soil, contributing to the synthesis of new compounds.

Microorganisms play an extremely important role in soil life. The organic part of the soil consists of plant and microorganism residues. The processes in the soil are closely connected with the life activity of microorganisms. Primarily, this involves the mineralization of plant and animal residues, material and energy exchange, and replenishment of nitrogen and carbon reserves. Microorganisms also play a significant role in enriching the soil with biologically active compounds such as amino acids, auxins, vitamins, and antibiotics.

JAH | Volume 5, Issue 09, September

The intensity of microbiological processes, the quantitative and qualitative composition of microflora in the soil largely depends on soil temperature, mechanical composition, water-air regime, organic matter supply, relief structure, erosion, as well as agronomic practices including the use of mineral fertilizers and depth of tillage.

Due to the biological assimilation of organic matter by microorganisms, organic compounds decompose in the soil. A wide variety of microorganisms such as bacteria, actinomycetes, fungi, algae, yeasts, lichens, protozoa, and lower animals live in the soil. Their numbers are extremely variable, reaching millions or billions per gram of soil. Soil properties, regimes, and fertility are shaped by microbiological activity. Understanding the causes of these processes, properties, and fertility, evaluating fertility, and managing it in the desired direction requires studying soil microbiological activity.

Proteins decompose most rapidly in soils, constituting 50% of the dry mass of cells. Proteins are decomposed by ammonifiers (aerobic and anaerobic bacteria), actinomycetes, and fungi. As a result of protein decomposition by these microorganisms, nitrogen is released in the form of ammonia. The ammonification process is of great importance in plant nutrition. Oligonitrophiles play a significant role in the transformation of nitrogen and carbon in the soil. This group of microorganisms decomposes the carbon component of the most important organic substances. Nitrogen-fixing bacteria can assimilate atmospheric nitrogen, and their accumulation in the soil can enrich it with nitrogen.

Actinomycetes are widespread soil microorganisms. They assimilate organic and mineral forms of nitrogen, decompose mono-, di-, and polysaccharides, as well as plant and animal oils. Some actinomycetes can decompose soil humus and chitin. They are resistant to high concentrations of salts, and some are capable of fixing atmospheric nitrogen.

Among other microorganisms in the soil, microscopic fungi also play a significant role in soil fertility. Numerous fungal species actively participate in decomposing plant residues. Soil fungi are important not only in soil biological processes but also in plant life. The role of fungi in nature and human economic activity is immense. For example, fungi produce many medicinal substances such as antibiotics and enzymes, but at the same time, they are responsible for several diseases of animals and crops. Thus, studying soil fungi has both scientific and practical importance.

As noted in the works of many researchers, the soils of Uzbekistan contain significantly fewer fungal mycelia compared to soils of other soil-climatic regions of the republic. Our research confirms this observation. This is explained by the extreme soil-climatic conditions of the region, such as lack of moisture, alkaline soil reaction, low organic matter content, and soil density. The number of microscopic fungi also depends on the degree of soil cultivation and the season of the year.

Materials and Methods

As the research object, typical rainfed (dryland) gray soils from the experimental field of the Dryland Farming Research Institute located in G‘allaorol district, Jizzakh region, were selected. In conducting microbiological analysis of the soil, commonly accepted methods in soil microbiology were applied [1, 4, 5].

To study the number of the main physiological groups in the soil, soil samples were taken from the 0–25 cm layer. Microorganisms in the studied soils were analyzed by inoculating them on specific nutrient media: ammonifying bacteria on GPA medium, oligonitrophiles on Ashby medium, actinomycetes on KA medium, and micromycetes on Chapek solid medium.

Results and Discussion

Based on the above, during our study the effect of different tillage methods and fertilization on the groups of microorganisms studied was investigated (Table 1).

Variant 1 (Traditional: Unfertilized – control). In this case, the counts were as follows: ammonifiers – $6.0×10^5$, oligonitrophiles – $1.6×10^5$, micromycetes – $1.4×10^3$, actinomycetes – $1.5×10^3$, phosphorus-solubilizing bacteria – $1.3×10^2$, and nitrogen-fixing bacteria – not detected (measured in CFU). Since the control represents the natural state of the soil, microorganisms were found in small numbers. This is explained by the lack of nutrient and energy sources in the soil. The low activity of ammonifiers and nitrogen-fixing microorganisms indicates weak humus turnover.

Variant 2 (Traditional: $P_{40}K_{40}$ in autumn + N_{40} during tillering). Here, the counts were: ammonifiers – $2.5×10^6$, oligonitrophiles – $5.1×10^5$, micromycetes – $2.1×10^3$, actinomycetes – $2.5×10^3$, phosphorus-solubilizing bacteria – $2.6×10^3$, and nitrogen-fixing bacteria – $1.5×10^3$ CFU. These results were somewhat higher compared to the control. This can be explained by the fact that the application of mineral fertilizers increased microbiological activity. In particular, phosphorus and potassium serve as energy sources for bacteria.

Variant 3 (Traditional: $P_{20}K_{20}$ in autumn + N_{20} during tillering). In this case, the counts were: ammonifiers – $2.8×10^6$, oligonitrophiles – $4.6×10^6$, micromycetes – $1.4×10^3$, actinomycetes – $1.9×10^3$, phosphorus-solubilizing bacteria – $2.1×10^3$, and nitrogen-fixing bacteria – $1.4×10^3$ CFU. Although the fertilizer rate was reduced, the high activity of ammonifiers was maintained. This indicates that these bacteria adapt quickly to the nutrient environment. The number of micromycetes and actinomycetes was moderate, suggesting a shortage of organic matter in the soil

Table 1

Effect of different tillage methods and fertilizers on soil microbiological activity

№	Variants	Types of microorganisms					
		Ammonifiers	Oligonitrophiles	Micromycetes	Actinomycetes	Phosphorus-decomposing bacteria	Nitrogen-fixing bacteria
	Traditional technology						
1	Fertilizer-free control	$6,0x10^5$	$1,6x10^5$	$1,4x10^3$	$1,5x10^3$	$1,3x10^2$	did not occur
2	P_{40} K_{40} – in the fall+ N_{40} – harvesting	$2,5x10^6$	$5,1x10^5$	$2,1x10^3$	$2,5x10^3$	$2,6x10^3$	$1,5x10^3$
3	P_{20} K_{20} – in the fall + N_{20} – harvesting	$2,8x10^6$	$4,6x10^5$	$1,4x10^3$	$1,9x10^3$	$2,1x10^3$	$1,4x10^3$

4	N_{20} P_{40} K_{40} – in the fall + N_{20} – harvesting	1,5x10^6	3,4x10^5	1,6x10^3	1,8x10^3	1,6x10^3	1,2x10^3
5	P_{40} K_{40} – in the fall + N_{40} – bunching + RG - tube laying	5,2x10^7	2,6x10^6	3,4x10^4	4,4x10^4	3,2x10^3	1,9x10^3
6	P_{40} K_{40} – in the fall + N_{40} – bunching + NK - tubing	4,3x10^7	8,3x10^5	2,7x10^3	3,3x10^3	2,8x10^3	1,7x10^3
	No-till technology						
7	Fertilizer-free control	2,2x10^6	3,3x10^5	1,4x10^3	2,0x10^3	1,4x10^2	1,1x10^3
8	P_{40} K_{40} – in the fall+ N_{40} – harvesting	6,1x10^7	9,3x10^5	3,4x10^4	4,2x10^4	2,1x10^3	2,0x10^3
9	P_{20} K_{20} – in the fall + N_{20} – harvesting	4,7x10^7	7,6x10^5	2,6x10^3	3,5x10^4	1,9x10^3	1,9x10^3
10	N_{20} P_{40} K_{40} – in the fall + N_{20} – harvesting	2,9x10^6	4,5x10^5	2,5x10^3	3,1x10^4	1,6x10^3	1,7x10^3
11	P_{40} K_{40} – in the fall + N_{40} – bunching + RG - tube laying	9,2x10^7	1,6x10^6	5,4x10^4	6,3x10^4	2,6x10^3	2,4x10^3
12	P_{40} K_{40} – in the fall + N_{40} – bunching + NK - tubing	7,4x10^7	1,1x10^6	4,5x10^4	5,8x10^4	2,5x10^3	2,2x10^3

Variant 4 (Conventional): Under the treatment $N_{20}P_{40}K_{40}$ in autumn + N_{20} at tillering, the counts were as follows: ammonifiers – 1.5×10^6, oligonitrophiles – 3.4×10^5, micromycetes – 1.6×10^3, actinomycetes – 1.8×10^3, phosphorus-solubilizing bacteria – 1.6×10^3, and nitrogen-fixing bacteria – 1.2×10^3 CFU. Despite fertilizer rates being doubled compared to Variant 3, no significant changes in the microbial population were observed.

Variant 5 (Conventional): $P_{40}K_{40}$ in autumn + N_{40} at tillering + RG during tubing. Counts: ammonifiers – 5.2×10^7, oligonitrophiles – 2.6×10^6, micromycetes – 3.4×10^4, actinomycetes – 4.4×10^4, phosphorus-solubilizing bacteria – 3.2×10^3, and nitrogen-fixing bacteria – 1.9×10^3 CFU. The combined use of mineral fertilizers and Rokogumin had a positive effect, significantly increasing microbiological activity compared to other variants.

Variant 6 (Conventional): $P_{40}K_{40}$ in autumn + N_{40} at tillering + NK during tubing. Counts: ammonifiers – 4.3×10^7, oligonitrophiles – 8.3×10^5, micromycetes – 2.7×10^3, actinomycetes – 3.3×10^3, phosphorus-solubilizing bacteria – 2.8×10^3, and nitrogen-fixing bacteria – 1.7×10^3 CFU. The application of mineral fertilizers with nanocrystalline silicon stimulated microbial group growth, though activity was lower compared to Variant 5, likely due to certain components creating less favorable conditions for microbes.

Variant 7 (No-till): Control without fertilizers. Counts: ammonifiers – 2.2×10^6, oligonitrophiles – 3.3×10^5, micromycetes – 1.4×10^3, actinomycetes – 2.0×10^3, phosphorus-solubilizing bacteria – 1.4×10^2, and nitrogen-fixing bacteria – 1.1×10^3 CFU. Even without fertilizers, higher activity was observed compared to conventional tillage control, as the soil's natural structure was preserved, providing a more favorable environment for microbes.

Variant 8 (No-till): $P_{40}K_{40}$ localized + N_{40} at tillering. Counts: ammonifiers – 6.1×10^7, oligonitrophiles – 9.3×10^5, micromycetes – 3.4×10^4, actinomycetes – 4.2×10^4, phosphorus-solubilizing bacteria – 2.1×10^3, and nitrogen-fixing bacteria – 2.0×10^3 CFU. Here, the No-till system combined with localized fertilization proved more effective, as microbes, particularly micromycetes and actinomycetes, developed actively in the presence of organic residues and nutrients.

Variant 9 (No-till): $P_{20}K_{20}$ localized + N_{20} at tillering. Counts: ammonifiers – 4.7×10^7, oligonitrophiles – 7.6×10^5, micromycetes – 2.6×10^3, actinomycetes – 3.5×10^3, phosphorus-solubilizing bacteria – 1.9×10^3, and nitrogen-fixing bacteria – 1.9×10^3 CFU. The significant microbial growth compared to other variants indicates enhanced humus formation and stable organic matter cycling under No-till. Notably, actinomycetes outnumbered micromycetes, reflecting their antibiotic properties and importance for soil health.

Variant 10 (No-till): $N_{20}P_{40}K_{40}$ localized + N_{20} at tillering. Counts: ammonifiers – 2.9×10^6, oligonitrophiles – 4.5×10^5, micromycetes – 2.5×10^3, actinomycetes – 3.1×10^3, phosphorus-solubilizing bacteria – 1.6×10^3, and nitrogen-fixing bacteria – 1.7×10^3 CFU. Under enhanced fertilization in No-till, ammonifiers dominated, indicating collaboration between microbial biomass and organic residues.

Variant 11 (No-till): $P_{40}K_{40}$ autumn localized + N_{40} at tillering + RG during tubing. Counts: ammonifiers – 9.2×10^7, oligonitrophiles – 1.6×10^6, micromycetes – 5.4×10^4, actinomycetes – 6.3×10^4, phosphorus-solubilizing bacteria – 2.6×10^3, and nitrogen-fixing bacteria – 2.4×10^3 CFU. Adding Rokogumin to mineral fertilizers under No-till significantly boosted microbial activity, with high levels of actinomycetes and micromycetes involved in stabilizing and decomposing chemical compounds.

Variant 12 (No-till): $P_{40}K_{40}$ autumn localized + N_{40} at tillering + NK during tubing. Counts: ammonifiers – 7.4×10^7, oligonitrophiles – 1.1×10^6, micromycetes – 4.5×10^4, actinomycetes – 5.8×10^4, phosphorus-solubilizing bacteria – 2.5×10^3, and nitrogen-fixing bacteria – 2.2×10^3 CFU. These results show that combining mineral fertilizers and nanocrystalline silicon in No-till created favorable conditions for microbial processes, ensuring stability of the microbiota through increased actinomycetes and micromycetes.

Nanocrystalline silicon (Si) strengthens soil microaggregates, creating a favorable ecological environment for microorganisms. This element enhances the strength of microbial cell walls, although its effect depends on dosage. Modified nanocrystalline silicon particles accelerate enzyme formation. This, in turn, indicates the active participation of actinomycetes in the intensification of humus formation processes.

This analysis reveals the significance of microbiological indicators not only for soil biota but also for overall agroecological stability. The advantages of the No-till technology were also proven by the increased microbiological activity of the soil.

The results of the conducted research indicate that various agrotechnological approaches and types of fertilizers have a significant impact on the main microbiological activity in the soil. Based on the above findings, we can draw the following generalized conclusions:

1. In conventional technology, under unfertilized control, microbiological activity was at a low level. Due to the lack of nutrient sources and unfavorable physical properties, the activity of ammonifiers and oligonitrophiles was limited.

2. In the variants with nitrogen, phosphorus, and potassium fertilizers, the activity of ammonifiers increased several-fold, confirming the essential role of these elements in microbial metabolism. In addition, the number of micromycetes and actinomycetes also increased under these conditions.

3. Organomineral fertilizers based on Rokogumin and humic acids emerged as important factors in revitalizing soil biota. In such an environment, all identified groups of microorganisms achieved particularly high activity.

4. Under No-till technology, even without fertilizers, microbiological activity was higher compared to conventional control. This is explained by the soil having relatively favorable agrophysical properties and better moisture retention.

5. Nanocrystalline silicon additives acted as stimulants of microbiological activity, creating a favorable environment especially for actinomycetes and micromycetes. These components also facilitated faster humus formation in the soil.

The highest activity was observed in variants 5, 8, and 11. In these cases, the combined use of fertilizers (mineral and organic) and the No-till system created the most favorable conditions for microorganisms. To ensure soil microbiological activity, it is advisable to apply the No-till technology together with humic substances and localized mineral fertilization. The combined use of silicon-based and organomineral substances is considered essential for the stable development of microbial groups.

References:

1.Seliber, G. L. (Ed.). (1962). Large Practical Guide on Microbiology. Moscow: Academy of Sciences of the USSR. 615 p.
2.Qodirova, D. A. (2010). Eroded soils of the Turkestan Ridge and their biological activity. Author’s abstract of dissertation for the degree of Candidate of Biological Sciences. Tashkent, 26 p.
3.Nabiyeva, G. M. (2008). Soils of the Western spurs of the Chatkal Ridge and their enzymatic activity. Author’s abstract of dissertation for the degree of Candidate of Biological Sciences. Tashkent, 30 p.
4.Zvyagintsev, D. G. (1991). Methods of Soil Microbiology and Biochemistry. Moscow: Moscow State University Press. 224 p.
5.Sagi, J. (1983). Methods of Soil Microbiology. (Trans. from Hungarian by I. F. Kurennoy). Moscow: Kolos. 296 p.