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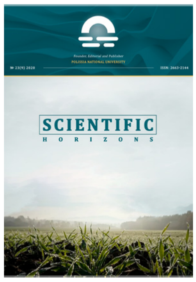

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Soil microbiomes as component of pedosphere biodiversity and factor in formation of crop yields

Viktoriia Skliar*
Doctor of Biological Sciences, Professor
Sumy National Agrarian University
40021, 160 Herasym Kondratiev Str., Sumy, Ukraine
https://orcid.org/0000-0002-1301-7384

Andrii Bortnik
PhD in Agriculture, Director
North-Western Interregional Centre of the State Institution "Institute of Soil Protection of Ukraine"
43010, 49 Hlushets Str., Lutsk, Ukraine
https://orcid.org/0000-0003-4292-0481

Inna Zubtsova
PhD in Biology, Associate Professor
Sumy National Agrarian University
40021, 160 Herasym Kondratiev Str., Sumy, Ukraine
https://orcid.org/0000-0001-6339-931X

Hanna Klymenko
PhD in Biology, Associate Professor
Sumy National Agrarian University
40021, 160 Herasym Kondratiev Str., Sumy, Ukraine
https://orcid.org/0000-0003-1859-4997

Anatolii Vakal
PhD in Biological Sciences, Associate Professor
Sumy State Pedagogical University named after A.S. Makarenko
40002, 87 Romenska Str., Sumy, Ukraine
https://orcid.org/0009-0009-9244-1375

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Abstract. The study aimed to evaluate the mechanisms of interaction between soil microbiomes and leading crops to optimise yields and product quality in agricultural production. A comprehensive analysis of the physical and chemical properties of soils (chernozems, grey forest and podzolic soils) and the composition of the soil microbiome, including the number of nitrogen-fixing bacteria *Rhizobium* and

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*Corresponding author

Azotobacter, bacteria *Bacillus* spp, representatives of the genus *Streptomyces*, and fungi *Glomus* spp. The highest yields of *Kalbex* wheat (50 c/ha), Rhodes corn (80 c/ha), and *Kingstone* soybeans (30 c/ha) were recorded when these crops were grown on black soils. Grey forest soils and podzolic soils showed lower productivity and crop quality. The number of nitrogen-fixing bacteria *Rhizobium* and Azotobacter in chernozems reached 6 million colony-forming units (CFU) per gram of soil, while in podzolic soils it was the lowest – 3 million CFU per gram of soil. The mycorrhizal fungi *Glomus* spp. were also most abundant in black soil, with 8 million spores per gram of soil. The study examined the impact of the soil microbiome on the yield of selected crops. A correlation analysis of the microbiome and yields was conducted. The impact of the soil microbiome on crop quality was analysed. The results confirmed that chernozems provide the best conditions for growing crops due to their high biological activity and optimal physical and chemical properties, making them an ideal choice for agronomic practice

Keywords: biodiversity; metagenomics; agroecosystems; pedosphere; agro-industrial complex; biogeochemistry; crop production

INTRODUCTION

Currently, there is a growing interest in the role of soil microbiomes in shaping crop yields. Soil microbiomes are central in maintaining plant vigour, improving nutrient availability and overall ecological balance. However, despite significant advances in this area, there are many gaps in understanding the specific impact of different microbiome components on crop yields and in applying this knowledge in practice. The study of soil microbiomes is relevant not only for understanding basic biological processes but also for developing new agronomic strategies that can significantly improve agricultural efficiency. Therefore, it is necessary to conduct a study that will integrate knowledge about soil microbiomes and yields into a single system.

Modern scientific research confirms the importance of soil microbiomes. W. Anthony *et al.* (2024) highlighted the importance of filling the gaps in soil metagenomics to improve understanding of microbiome functions and their impact on the soil ecosystem. This information is important for an accurate assessment of how microbiomes affect fertility and, consequently, crop yields. In turn, S. Banerjee and M. van der Heijden (2022) considered the concept of "one health" and its importance for soil microbiomes, emphasising their impact on the overall health of ecosystems and on plant health and yield. The study of global soil carbon management as a key aspect for understanding and maintaining the largest terrestrial carbon reserve was carried out by J. Scharlemann *et al.* (2023). This study demonstrated how managing soil carbon can affect microbiomes and their ability to maintain soil fertility. R. Wu *et al.* (2021) studied the effect of moisture on the activity of viruses in soil, which can indirectly affect microbiomes and their functional properties. This shows that changes in environmental conditions can modify soil microbiomes and thus affect plant productivity.

F. Bastida *et al.* (2021) and R. Riley *et al.* (2021) conducted research showing that microbiome diversity and functional abilities have a significant impact on soil health and, consequently, on yields. The results also show that a deeper understanding of microbiomes at different levels can help to develop new strategies to improve the productivity of agricultural systems. Different approaches to metagenomic data collection for the creation of biome-specific gene catalogues were studied by L. Delgado and A. Andersson (2022). The authors compared methods for collecting and analysing metagenomic data, which allow for more accurate and detailed profiles of microbiomes for specific environmental environments. Y. Zhou *et al.* (2024) found that root microbiomes adapted to local conditions can enhance plant growth and development, which is important for optimising yields.

M. Hartmann and J. Six (2023) examined the relationship between soil structure and microbiome functions in agroecosystems, analysing how soil structure affects the microbiome and how microbiomes can in turn modify soil structure, which is important for improving agronomic practices and increasing productivity. J. Jansson *et al.* (2023) discussed soil microbiome engineering as a strategy to increase the resilience of agroecosystems in a changing environment and proposed different approaches to modifying microbiomes to improve their functionality and resilience to environmental change.

The interaction between plants and their microbiomes, including the processes of formation of microbiome communities and their impact on plant health, was studied by P. Trivedi *et al.* (2020). They also stressed the importance of these interactions for increasing yields and plant health. J. Guo *et al.* (2021) analysed the main microbiota accompanying seeds, the endosphere and rhizosphere, and how these microbiotas can predict plant functional characteristics in different rice varieties, and found the dominance of deterministic processes in the formation of microbiomes. B. Singh *et al.* (2020) studied the role of crop microbiomes in sustainable agriculture and highlighted the importance of microbiomes for increasing the productivity and resilience of agricultural systems, as well as for improving soil and plant health. M. Jiang *et al.* (2024) proposed a solution based on home microbial cultures to improve plant growth on soils with low fertility, demonstrating the effectiveness of using specific microbiomes to increase yields in conditions of limited fertility. J. Hu *et al.* (2021) investigated the effect of probiotic bacterial consorts on plant growth through the influence on the resident rhizosphere microbiomes and found that the introduction of probiotic consorts can positively affect plant health and increase plant growth.

The study aims to identify the leading features of soil microbiome biodiversity in different agricultural environmental conditions of the Sumy region and to assess their impact on crop yields. It is necessary to determine which components of the microbiome are most important for increasing productivity and how they can be effectively used to improve agronomic practices, and it is also advisable to assess the impact of microbiomes on the quality parameters of agricultural products. The answer to this question involves filling a gap in existing knowledge and providing practical recommendations for agronomists and farmers.

MATERIALS AND METHODS

To achieve the research objective, a comprehensive experiment was conducted, which included several key stages. The study was conducted from March to October 2024 on agronomic plots in the Sumy region, which is a region with a variety of soil types and agroclimatic conditions that significantly affect agricultural production. To ensure the comprehensiveness of the study, several locations were selected that differ not only in soil type but also in crops grown, which was used to study in more detail the impact of different agricultural technologies on crop productivity and quality. The study plots were characterised by the following soil types: podzolised chernozems, grey forest soils and sod-podzolic soils. This approach provides objective data and recommendations for improving agronomic practices in the region. Sampling and materials – samples were obtained from a depth of 0-30 cm, which is optimal for studying the root zone of plants. The microorganisms isolated from the soil, including bacteria and fungi, were identified using modern molecular methods.

Equipment and methods – spectrophotometers (Thermo Fisher Scientific, model NanoDrop – United States of America), pH meters (Metrohm 780 pH Meter – USA), and soil texture analysers (Zehntner ZH 2000 – Switzerland) were used to determine the content of basic nutrients and soil humus. For the identification of microorganisms, automatic systems for deoxyribonucleic acid sequencing (Illumina NovaSeq 6000 – USA), microscopes (Olympus BX53 – Japan), incubators for cultivating microorganisms (Eppendorf ThermoMixer C – Germany), and specialised kits for polymerase chain reaction (Thermo Scientific TaqMan Universal Master Mix – USA) were used. Traditional agronomic methods were used to assess crop yields, including weighing agricultural products and analysing their quality:

To assess the relationship between the characteristics of the soil microbiome and crop yields, Pearson's correlation coefficients were calculated. This statistical method was used to determine the strength and direction of the linear relationship between the two variables. In general, the statistical processing of the research results was carried out using the statistical computer packages STATISTICA and PAST. Study procedure – soil samples were prepared by drying, crushing and dividing into sub-samples for different types of analysis. Appropriate laboratory techniques were used to extract microbial DNA from the soil, including polymerase chain reaction and DNA sequencing to identify microbial species. Wheat, corn and soybean seeds were sown on the prepared plots. During the growing season, the plants were regularly monitored for phenological growth and development, biometric measurements, and quantitative and qualitative yield indicators. The collected data were analysed using statistical methods, which identified correlations between soil microbiome characteristics and crop yields.

Materials used – chemical reagents: standard reagents for determining the physical and chemical properties of soil, such as solutions for analysing the content of macro- and microelements, humus and hydrogen ions; technical equipment: laboratory centrifuges, automatic pipettes, spectrophotometers, incubators and other data collection devices. Thus, the study included a systematic approach to analysing the impact of soil microbiomes on crop yields, which provided new data and recommendations for improving the efficiency of agronomic practices.

RESULTS

The studied podzolic soils proved to be the most fertile, as physicochemical analysis confirmed that they have the highest humus content, which indicates their ability to provide plants with the necessary nutrients (Table 1). In addition, podzolic chernozems demonstrated the best pH values, which is an important factor for optimal plant growth and development.

***Table 1**. Physical and chemical properties of soils of different types*

Soil type	pH (salt, unit)	Humus content (%)	Nitrogen nitrate (N-NO_3, mg/kg)	Phosphorus (P_2O_5, mg/kg)	Potassium (K_2O, mg/kg)
Chornozem	6.5	3.2	15	45	180
Grey forest soils	5.8	2.5	10	35	150
Sod-podzolic soils	4.9	1.8	8	25	120

***Source:** compiled by the authors*

The analysis of the soil microbiome revealed significant differences in the composition of microorganisms depending on the soil type in chernozems, the largest share of microbial biomass consists of bacteria, which account for approximately 60% of the total mass of microorganisms. The remaining 40% is accounted for by fungi, which are also significant in maintaining the soil ecosystem by contributing to the decomposition of organic residues and improving soil structure (Table 2).

***Table 2**. Composition of the soil microbiome by type*

Soil type	Bacteria (% of total biomass)	Mushrooms (% of total biomass)
Chornozem	60	40
Grey forest soils	55	45
Sod-podzolic soils	50	50

***Source:** compiled by the authors*

In grey forest soils, which are characterised by high humidity, a slightly higher percentage of fungi was observed in the microbiome, which may be due to favourable conditions for the development of fungal colonies, as the moist environment promotes their growth and reproduction. Fungi in such soils can perform important ecological functions, in the processes of symbiotic relationships with plants. The sod-podzolic soils, in turn, showed the most balanced distribution between bacteria and fungi, indicating complex ecological interrelationships in their soil-absorbing complex. This balance can indicate the diversity of microbial species and their ability to adapt to specific environmental conditions, which in turn affects the overall productivity of the soil.

The results of the experiment with the detection of fungi and bacteria were as follows: the number of nitrogen-fixing bacteria *Rhizobium* and *Azotobacter* in podzolic black soils reached 6 million colony-forming units (CFU)/g of soil, which indicates a high nitrogen-fixing capacity of these soils to supply nitrogen to plants, which is critical for growth and development. In grey forest soils, the number of nitrogen-fixing bacteria was slightly lower, at 4.5 million CFU/g soil. Although these soils also provide a certain level of nitrogen, their efficiency is slightly lower compared to black soil. The sod-podzolic soils had the lowest number of nitrogen-fixing bacteria, at 3 million CFU/g soil. This may explain the limited availability of nitrogen and, consequently, lower crop yields on these soils.

The number of representatives of *Streptomyces* in podzolic chernozems reached 4 million CFU/g of soil, which contributes to the efficient decomposition of organic matter and the synthesis of beneficial metabolites that have a positive effect on plant health. In grey forest soils, the number of actinomycetes was 3 million CFU/g soil, indicating moderate activity in the decomposition of organic matter. Sod-podzolic soils showed the lowest number of actinomycetes – 2 million CFU/g soil. This may be due to lower soil productivity due to less efficient decomposition of organic materials. The number of phosphate-mobilising bacteria *Bacillus* spp. in the podzolised chernozem was 3 million CFU/g soil. This indicates an intensification of the processes of formation of mobile phosphorus compounds, which, accordingly, contributes to an increase in the availability of this element to plant organisms. In grey forest soils, the number of phosphate-mobilising bacteria was 2.5 million CFU/g soil, which provides a certain level of phosphorus but is lower than in black soil. Sod-podzolic soils had the lowest number of phosphate-mobilising bacteria – 1.5 million CFU/g soil, which accordingly reduced the level of availability of mobile forms of this element for plants and harmed crop yields. The analysis of the results of studies on the identification of fungi in the soil-absorbing complex indicates the following pattern: 8 million spores of mycorrhizal fungi *Glomus* spp. per gram of soil were found in podzolic chernozems. Mycorrhizal fungi form symbiotic relationships with plant roots, which improves water and nutrient absorption and increases plant resistance to stressful conditions (Myronycheva *et al.*, 2017). Grey forest soils were characterised by an indicator of 5 million mycorrhizal fungal spores per gram of soil, indicating a lower but still significant activity in improving plant growth and development. The number of mycorrhizal fungal spores in sod-podzolic soils was 4 million per gram of soil. Despite the lower number of mycorrhizal fungi, their presence still contributes to the improvement of plant conditions.

Fungi *Trichoderma* spp. was found in podzolic chernozems in the amount of 5 million spores per gram of soil. These fungi actively promote the decomposition of organic residues and increase the biological activity of the soil. Grey forest soils contained 4 million spores of such fungi per gram of soil, which demonstrates their moderate role in decomposition processes. Sod-podzolic soils were characterised by a content of 3 million spores of fungi of this group per gram of soil, which may explain the less efficient decomposition of organic materials. The presence of pathogenic fungi *Fusarium* spp. was recorded in podzolic chernozems in the amount of 2 million spores per gram of soil. Low numbers of pathogens indicate better plant resistance to disease. Grey forest soils showed the presence of 3 million pathogenic fungal spores per gram of soil, indicating a moderate level of infection risk. Sod-podzolic soils contained 4 million pathogenic fungal spores per gram of soil. Higher numbers of pathogens can cause increased plant stress and lower yields.

The results of the analysis showed that a higher number of nitrogen-fixing bacteria and mycorrhizal fungi in chernozems contributes to higher crop yields. Podzolised chernozems with a high content of phosphate-mobilising bacteria and mycorrhizal fungi provide the highest quality and quantity of crops (Biyashev *et al.*, 2024). Grey forest soils and sod-podzolic soils show a lower number of beneficial microorganisms, which partly explains their reduced productivity and slightly lower product quality. The high number of pathogenic fungi in sod-podzolic soils can harm plant health and yield (Havryliuk *et al.*, 2024). The study's analysis of wheat, corn and soybean yields showed that soil type has a significant impact on the productivity of these crops. Podzolic black soils showed the highest yields for all three crops. *Kalbex* wheat grown on podzolised black soil yielded 50 centners per hectare, *Rhodes* corn 80 centners, and *Kingstone* soybeans 30 centners. This is due to the high humus content of chernozems and their favourable physical and chemical properties, such as optimal pH and high forage retention capacity. Black soil promotes better development of the root system of plants and provides them with essential nutrients, which in turn leads to high yields (Pichura *et al.*, 2023; Voitovyk *et al.*, 2023). The quality of grain obtained from plants grown on black soil was also the best. The weight of 1,000 grains of wheat was 38 grams, corn 250 grams, and soybeans 200 grams.

The yields of crops grown on sod-podzolic soils were the lowest. *Kalbex* wheat yielded 40 centners per hectare, *Rhodes* corn 70 centners and *Kingstone* soybeans 25 centners. The low humus content and poor moisture retention in these soils limit crop productivity. Grain quality was also the lowest, with wheat weighing 33 grams per thousand grains, corn 230 grams and soybeans 180 grams. Grey forest soils had intermediate yields. The *Kalbex* wheat yielded 45 centners per hectare, *Rhodes* corn 75 centners, and *Kingstone* soybeans 28 centners. Grain quality was slightly lower than on podzolic black soil but better than on podzolic soils. The correlation analysis conducted as part of the study revealed a significant positive correlation between the number of bacteria in the soil and crop yields (Fig. 1). This result can be explained by the fact that bacteria play an important role in improving soil quality, as they contribute to the synthesis and mineralisation of organic matter and increase the availability of important nutrients such as nitrogen and phosphorus. These processes allow plants to absorb nutrients more efficiently, which in turn leads to higher yields.

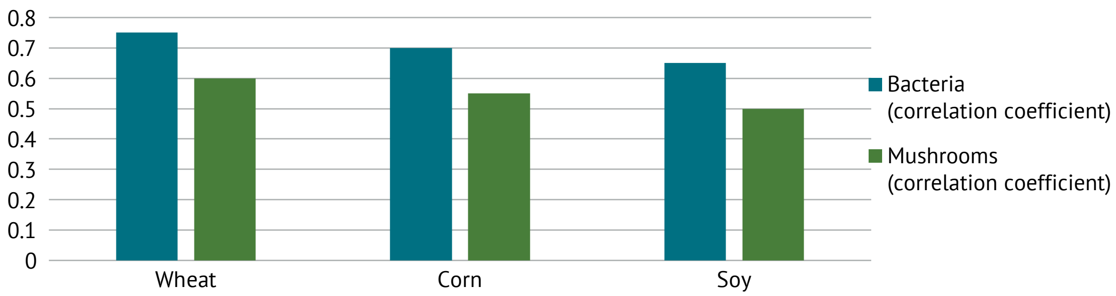

Figure 1*. Correlation between soil microbiome and crop yields*

Source: *compiled by the authors*

As for the correlation between the number of fungi in the soil and crop yields, it was less pronounced but still has some positive aspects. Although the impact of fungi on yields is less significant than that of bacteria, their presence can also have a positive impact on the overall health of the soil and plants. Thus, the results of the study emphasise the importance of soil microbiological composition for agronomic productivity. The study also examined the dynamics of changes in the physical and chemical properties of the soil during the growing season of crops. It turned out that podzolised chernozems, which have a high humus content and neutral pH, retain their optimal properties throughout the season. At the beginning of the experiment (in March), the humus content in the podzolic chernozems was 3.2%, and the soil solution reaction index (pH) was 6.5. At the end of the research (October), these indicators decreased to 3% and 6.4, respectively, which indicates a slight decrease in organic material and a decrease in pH. However, the studied parameters remained within the optimal range.

In March, grey forest soils were characterised by a lower humus content (2.5%) and a close to neutral soil solution pH (5.8 units). At the end of the growing season (October), these figures decreased to 2.3% and 5.7 units, respectively. This indicates a slight decrease in the content of minor acidification of the soil environment, which can affect the efficiency of nutrient uptake by plants. The sod-podzolic soils had the lowest humus content (1.8%) and were characterised by a medium acid reaction of the soil solution (pH 4.9 units). At the end of the season, these indicators decreased to 1.7 and 4.8%, respectively. This indicates a low level of fertility and the need for pH correction to improve conditions for plants.

The study of the quality of the crop showed that black soils provide the best results. For instance, wheat grain grown on these soils contained 12.5% protein and, accordingly, provided the highest evaluation scores. Grain produced on grey forest soils was characterised by lower values: 11.8% protein and slightly lower quality. Wheat grain products produced on sod-podzolic soils had the worst results: 11.2% protein and the lowest grain quality scores. A similar situation was observed concerning the sucrose content in corn grain. Thus, in the products grown on podzolic black soil, the content of this indicator was 6.5% with the highest evaluation scores. The sucrose content in the grain grown on grey forest soils was 6% and in sod-podzolic soils – 5.5%. As for soybean grain, when grown on podzolic black soils, the protein content was 38%, while on grey forest soils, it was 37.5%, and on sod-podzolic soils, it was 37%.

The analysis of the above data showed that different soil types and microbiome composition have a significant impact on crop productivity. Podzolic chernozems, which are characterised by a high humus content and favourable conditions for the development of beneficial microorganisms, show the highest yields. This confirms their high agronomic value and importance for agricultural production. Considering the microbiological aspects of the soil can be a key factor in improving the efficiency of agronomic practices and optimising crop yields in a changing climate.

DISCUSSION

A detailed study focusing on the effect of probiotic bacterial consortia on plant growth was conducted by J. Hu *et al.* (2021). They focused on their impact on the rhizosphere microbiome. Our results confirm that modifying the microbiome by introducing probiotic consortia can significantly improve plant growth. These findings are consistent with the present study, which indicates the importance of microbiological factors in plant development. In addition, Z. Ruan *et al.* (2024) studied the application of microbiome modelling in the context of improving bioremediation, which is an important topic in ecology. The results of their study confirm that appropriate management and modelling of microbiomes can have a positive impact on the functioning of agroecosystems, as well as on the agronomic characteristics of crops. Thus, the integration of microbiological approaches into agronomic practice has the potential to increase agricultural efficiency and preserve the environment.

A detailed analysis of the patterns of microbial community recovery in different environments was carried out by S. Jurburg *et al.* (2024), which includes both natural and anthropogenic ecosystems. This research is relevant for determining how microbiomes influence the resilience of agroecosystems to change, particularly in the face of climate change and intensive land use. The study of microbial communities can provide valuable information on how they interact with plant species and other organisms, which in turn can contribute to the development of more effective agroecosystem management strategies. L. Philippot *et al.* (2021) addressed the resilience of microbial communities to environmental changes and stressors. The results of this study confirm that soil microbiomes have a significant ability to adapt to environmental changes, which is critical for maintaining ecological balance. These findings highlight the importance of microbial communities in ensuring ecosystem resilience and can serve as a basis for further research in agronomy and ecology.

The effects of priority in the formation of microbiomes, which is a highly important aspect of understanding ecosystem processes, were studied by R. Debray *et al.* (2022). The study determined that the first microbiomes that inhabit the soil can significantly influence the further development and formation of subsequent microbial communities. This observation highlights the importance of initial conditions in shaping soil biodiversity, which can have far-reaching implications for agronomy and ecology. P. Jiang *et al.* (2024) analysed the impact of intercropping on maize growth and nutrient uptake, addressing the relationship between rhizosphere metabolites and microbiomes. This study confirms the results of previous research indicating that agronomic practices, such as organic fertilisation, can significantly alter the structure of the soil microbiome. This, in turn, affects plant health and growth, which is critical for high yields and sustainable agriculture.

A detailed study of the changes in microbial communities that occur during long-term intercropping was conducted by R. Ablimit *et al.* (2022). This study highlights how the long-term use of certain agronomic practices, such as fertilisation, can significantly affect the composition and functioning of the soil microbiome. Changes in microbial communities can have far-reaching consequences for soil fertility, disease resistance and the overall ecological balance in agroecosystems (Khavkhun, 2024). The impact of phosphate fertilisers on the soil microbiome and its metabolic functions was studied by H. Cheng *et al.* (2022). The results of this study confirm the existing findings on the importance of proper fertilisation, as it can significantly affect the health of microbiomes. In particular, the study determined that excessive or insufficient fertiliser application can lead to an imbalance in microbial communities, which in turn can negatively affect soil fertility and the environmental sustainability of agricultural systems.

The factors that influence differences in the distance-decreasing relationships of microbiomes were considered in detail, in the context of environmental conditions and biodiversity, by D. Clark *et al.* (2021). The results of the study confirm that these differences can have a significant impact on the functioning of microbiomes in different environments, which in turn can affect the overall health of ecosystems and their resilience to environmental change. This study highlights the importance of understanding microbiomes for developing strategies for the conservation and restoration of natural resources. P. Neuberger *et al.* (2024) studied the role of arbuscular mycorrhizae in soils, focusing on their ability to improve nutrient availability to plants. This supports these findings on the importance of mycorrhizae for improving soil and plant health, in the context of increasing soil fertility and reducing the need for chemical fertilisers. P. Neuberger *et al.* emphasise that arbuscular mycorrhizae not only promote plant growth but also play an important role in maintaining ecological balance, making them indispensable components of healthy agroecosystems. The results of the study by Y. Qiao *et al.* (2024) proved that the accumulation and application of organic residues, such as straw, is a factor in enriching soil microbiomes and increasing their biodiversity.

The integration of phenotypes into microbiome networks for the design of synthetic communities, focusing on the potential of microbiome networks to improve agronomic practices, was studied by R. Poudel *et al.* (2023). This study confirms the findings that structured microbiome communities can be used to optimise agronomic processes such as biological pest control and soil fertility, opening new opportunities for sustainable agriculture and organic farming. T. Aizi *et al.* (2023) carried out a detailed analysis of the structure of microbial communities existing in the rhizosphere of *Panax ginseng* and investigated soil properties in larch forests. This study not only adds to existing results but also demonstrates how rhizosphere microbiomes can vary depending on specific soil conditions and temporal changes. The importance of this study is to emphasise the contextual factors that significantly affect the formation and functioning of microbiomes. Moreover, L. Mason *et al.* (2023) studied changes in the composition of microbial communities in the root zone during intercropping. These results confirm previous data indicating that intercropping can significantly affect soil microbiomes. The study by L. Mason *et al.* emphasises the importance of agronomic practices in the formation of sustainable and balanced soil ecosystems, which in turn can contribute to increased crop yields and sustainability.

A detailed study examining the effect of cultivation duration on the aggregation of microbial taxa was conducted by Z. Shi *et al.* (2023). In their work, the authors also emphasise that the duration of agronomic practices can significantly affect the structure and functioning of microbiomes. The results demonstrating this dependence are consistent with previous findings by other researchers, which indicates the importance of long-term use of certain agronomic practices to optimise microbiomes in soil. In turn, V. Pandey *et al.* (2023) conducted a comprehensive analysis of the history and role of microbiomes in plant improvement, focusing on their ability to increase plant resistance to stress and improve growth performance. This study confirms the findings of previous research that indicates the long-term benefits of using microbiomes to improve plant health. The importance of microbiomes in modern agriculture is becoming increasingly evident, as they are central to ensuring food security and sustainable development of the agricultural sector.

The results of the study are consistent with the findings of other scientists, who confirm that soil microbiomes are an important component of pedospheric biodiversity and a powerful factor in shaping crop yields. The importance of microbiomes in ensuring the sustainability of agroecosystems is critical in the context of climate change and global challenges in agriculture. The results obtained can serve as a basis for further research in microbiome science and agronomy, opening new opportunities for the development of environmentally friendly agricultural technologies and soil management strategies that will contribute to the sustainable development of the agricultural sector.

CONCLUSIONS

The study assessed the state of microbiome biodiversity in different agricultural conditions of the Sumy region and conducted their inventory. A significant influence of soil microbiomes on the yield and quality of crops, in particular, wheat "*Kalbes*", corn "*Rhodes*" and soybeans "*Kingston*", was established. The highest yields were recorded when growing crops on podzolic black soil: wheat reached 50 cwt/ha, corn – 80 cwt/ha, soybeans – 30 cwt/ha, which indicates optimal conditions for plant growth and development on this type of soil. Grey forest and sod-podzolic soils showed lower yields, which is due to their lower biological activity and less favourable physical and chemical characteristics. In particular, the number of nitrogen-fixing bacteria *Rhizobium* and *Azotobacter* and mycorrhizal fungi *Glomus* spp. was significantly higher in podzolic chernozems, which had a positive impact on the availability of nutrients for plants. The content of humus and mobile forms of phosphorus was also the highest in these soil types, confirming their high fertility.

The correlation analysis revealed significant positive correlations between the number of bacteria in the soil and crop yields, as bacteria contribute to soil quality, decomposition of organic matter and increased availability of nutrients. The correlation between the number of fungi in the soil and yields was less pronounced, but mycorrhizal fungi are known to have a positive effect on the ability of plants to absorb water and nutrients. The results of the study emphasise the importance of optimal soil microbiological composition for agronomic productivity. However, the study has certain limitations, such as the localised range of soil conditions and crops, which may affect the generalisability of the results. To further improve the results, it is recommended to expand the study to other soil types and crops, as well as to address seasonal fluctuations and the long-term impact of various agronomic practices on soil microbiomes. This will be used to assess the impact of microbiomes on agroecosystems and develop more effective methods for increasing crop productivity.

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None.

CONFLICT OF INTEREST

None.

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Мікробіоми ґрунту як складова біорізноманіття педосфери та чинник формування врожайності сільськогосподарських культур

Вікторія Скляр
Доктор біологічних наук, професор
Сумський національний аграрний університет
40021, вул. Герасима Кондратьєва, 160, м. Суми, Україна
https://orcid.org/0000-0002-1301-7384
Андрій Бортник
Кандидат сільськогосподарських наук, директор
Північно-Західний міжрегіональний центр державної установи «Інститут охорони ґрунтів України»
43010, вул. Глушець, 49, м. Луцьк, Україна
https://orcid.org/0000-0003-4292-0481
Інна Зубцова
Кандидат біологічних наук, доцент
Сумський національний аграрний університет
40021, вул. Герасима Кондратьєва, 160, м. Суми, Україна
https://orcid.org/0000-0001-6339-931X
Ганна Клименко
Кандидат біологічних наук, доцент
Сумський національний аграрний університет
40021, вул. Герасима Кондратьєва, 160, м. Суми, Україна
https://orcid.org/0000-0003-1859-4997
Анатолій Вакал
Кандидат біологічних наук, доцент
Сумський державний педагогічний університет імені А.С. Макаренка
40002, вул. Роменська, 87, м. Суми, Україна
https://orcid.org/0009-0009-9244-1375

Анотація. Метою даного дослідження було оцінювання механізмів взаємодії між мікробіомами ґрунту та провідними культурами для оптимізації врожайності і якості продукції у процесі сільськогосподарського виробництва. У ході дослідження проведено всебічний аналіз фізико-хімічних властивостей ґрунтів (чорноземи, сірі лісові та підзолисті) та склад мікробіому ґрунту, включаючи чисельність азотфіксуючих бактерій *Rhizobium* і *Azotobacter*, бактерій *Bacillus* spp., представників роду *Streptomyces*, грибів *Glomus* spp. Найвищі показники врожайності пшениці сорту *Kalbex* (50 ц/га), кукурудзи Родос (80 ц/га) та сої *Kingstone* (30 ц/га) були зареєстровані при вирощуванні цих культур на чорноземах. Сірі лісові ґрунти і підзолисті ґрунти продемонстрували меншу продуктивність та якість врожаю. Чисельність азотфіксуючих бактерій *Rhizobium* і *Azotobacter* у чорноземах досягала 6 мільйонів колонієутворюючих одиниць (КУО) на грам ґрунту, тоді як у підзолистих ґрунтах вона була найнижчою – 3 мільйони КУО на грам ґрунту. Мікоризні гриби *Glomus* spp. також були найбільш чисельні в чорноземах – 8 мільйонів спор на грам ґрунту. У дослідженні вивчався вплив мікробіому ґрунтів на врожайність обраних культур. Був проведений кореляційний аналіз мікробіому та врожайності. Проаналізовано вплив мікробіому ґрунту на якість врожаю. Отримані результати підтверджують, що чорноземи забезпечують найкращі умови для вирощування культур завдяки високій біологічній активності ґрунту та оптимальним фізико-хімічним властивостям, що робить їх ідеальним вибором для агрономічної практики

Ключові слова: біорізноманіття; метагеноміка; агроекосистеми; педосфера; агропромисловий комплекс; біогеохімія; рослинництво