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MICROBIOTA IN THE RHIZOSPHERE OF CEREAL CROPS

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Today, spelt wheat grain is used to produce high quality food. Intermediate wheatgrass is a promising crop for prairie restoration. One of the elements of biologization is the influence of growing crops on the microbiota of soil rhizosphere. The microbiota of spelt wheat and intermediate wheatgrass soil rhizosphere remains insufficiently studied. ***Aim****. To study the number of individual groups of microbiota in dynamics in the rhizosphere of cereal crops (spelt wheat, intermediate wheatgrass) depending on the weather conditions and the phase of plants development.* ***Methods.*** *Classical microbiological, statistical methods were used in the work. In particular, the study of the number of microorganisms of different ecological and trophic groups (ammonifying, nitrifying, cellulolytic and nitrogen-fixing) was carried out according to generally accepted methods in soil microbiology. The reliability of the influence of factors was determined by the probability value «p» level which was calculated using STATISTICA 8 program.* ***Results.*** *The amount of ammonifying and cellulolytic microorganisms in the soil rhizosphere of spelt wheat is significantly higher compared to soft wheat. The rhizosphere microbiota amount of the intermediate wheatgrass on the 2–3 year of cultivation was more resistant to adverse environmental factors compared to soft wheat. The soil rhizosphere microbiota did not change a lot depending on the phase of plant development during the vegetation period of cereal crops (spelt wheat, intermediate wheatgrass).* ***Conclusions.*** *The formation of rhizosphere microbiota of spelt wheat and intermediate wheatgrass was first analyzed under the conditions of the Right-Bank forest-steppe of Ukraine. The conducted studies indicate the feasibility of growing and use of spelt wheat in breeding programs to create cultivars of soft wheat with higher activity of rhizosphere microbiota. The number of ammonifying, nitrifying and cellulolytic microorganisms of soil rhizosphere of intermediate wheatgrass was significantly higher compared to soft wheat during all growth stages. The conducted studies confirm the practical application of intermediate wheatgrass to preserve and increase soil fertility. Intermediate wheatgrass can be grown for up to three years in one field, as microbiological activity reaches its maximum development.*

Keywords: microbiota, ammonifying, nitrifying, cellulolytic microorganisms, Azotobacter, rhizosphere, soft wheat, spelt wheat, intermediate wheatgrass.

The microbiota of the rhizosphere plays an important role because it produces vitamins, amino acids, heteroauxins, enzymes that affect plant development. Besides, this group of microorganisms takes part in the process of nutrients coming from the soil into the root system, inhibits the development of harmful microorganisms, and stimulates endosymbiosis of plants with microorganisms [1].

Modern agricultural technologies cause ecosystem soil erosion, greenhouse gas emissions and water pollution despite the increase in production of plant raw material [2]. Spelt wheat is now a famous crop in the world which is used to produce high quality products [3]. Intermediate wheatgrass is good for food and fodder purposes (green fodder, silage, haylage, hay). In addition, these crops are of low maintenance to growing conditions, able to form yield, especially in the conditions where soft wheat does not form it [4]. They require less fertilizer, help to prevent water flow, are more resistant to drought compared to annual cereal crops due to the long vegetation period of perennial cereal crops and deep root system [5]. Restoration of soil fertility with the use of prairie restoration with perennial cereal crops is a priority task in the United Nations strategy [6].

Plant species, as well as soil type, had a significant impact on the structure and function of microbial populations connected with the rhizosphere. In addition, these factors could affect in different ways the number of microorganisms depending on biotic and abiotic conditions [7, 8]. It is known [9] that spelt wheat had advantages over soft wheat in organic agrotechnologies. However, in these studies there was no data on the formation of spelt wheat rhizosphere microbiota.

The results of a study of other scientists [10, 11] showed that wild perennial grasses contained different groups of fungi in the rhizosphere depending on the season, in particular ascomycetes were dominant. However, these researchers did not study the number of individual ecological and trophic groups of microorganisms.

Analysis of the literature showed a significant impact of the activity of microorganisms on the productivity of agricultural crops and soil fertility. However, spelt wheat and intermediate wheatgrass microbiota remains insufficiently studied. The study of this issue will give the possibility to partially identify the plants adaptability to the environmental conditions taking into account the importance of the microbiota in the synthesis of biochemical components used by the plant. The greater the microbiota number, the higher the plants adaptability was. It was manifested in the formation of more stable yields and grain quality in spelt wheat, and in the yield of the vegetative mass in intermediate wheatgrass. Therefore, it is topical to study the influence of growing spelt wheat and intermediate wheatgrass on the microbiota formation in their rhizosphere, which is important for the characteristics of the plants adaptability and ecological and functional characteristics of the soil.

The purpose is to study the number of individual groups of microbiota in dynamics in the rhizosphere of different cereal crops (soft wheat, spelt wheat, intermediate wheatgrass) depending on the weather conditions and the phase of plants development.

Materials and methods. Studies of the number of different ecological and trophic groups of microorganisms were performed in the field and laboratory conditions in the Uman National University of Horticulture during 2017–2019 years. Kalancha (Ukraine) – a cultivar of soft winter wheat (*Triticum aestivum* L.), Zoria Ukrainy (Ukraine) – spelt wheat (*Triticum spelta* L.), Khors (Ukraine) and Kernza (USA) – intermediate wheatgrass (*Elytrigia intermedia* (Host) Nevski) were used in the experiment. Kernza cultivar was obtained by hybridization of *Triticum aestivum* L. / *Elytrigia intermedia* (Host) Nevski.

The number of microorganisms was determined in the stem elongation phase, earing phase, phase of milk ripeness of grain, in particular ammonifying – on agarized medium of meat-and-peptone agar, nitrifying – on the liquid medium of S. N. Winogradsky, cellulolytic – on the liquid medium of A. A. Imsheneckii and L. I. Solntseva. The number of ammonifying microorganisms was expressed in colony-forming units (CFU). The number of nitrifying and cellulolytic microorganisms was expressed in $N \cdot 10^3$ cells/g of soil. Studies of nitrogen-fixing microorganisms of the *Azotobacter* genus were performed on Ashby medium, and their number was expressed in % of soil lumps surrounded by colonies. Determination of the number of microorganisms was performed three times. Grouping of the variation coefficient was done according to the following gradations: 0–10 % – insignificant, 10–20 – small, 20–40 – medium, 40–60 – large, ≥ 60 % – very large. Statistical data processing was performed using Microsoft Excel 2010 and STATISTICA 8. Interpretation of the influence level by partial coefficient (thumb rule – Cohen): 0.02–0.13 – weak, 0.13–0.26 – medium, ≥ 0.26 – high. The “null hypothesis” was confirmed or refuted during the performing of variance analysis. The value of the coefficient “p” was determined for this purpose, which showed the probability of the corresponding hypothesis. In cases where $p<0.05$ “the null hypothesis” was refuted and the influence of the factor was significant.

The experimental plot was located in Mankivka natural-and-agricultural district of the Middle-Dnieper-Buh district of the Forest-Steppe Right-Bank province of the Forest-Steppe zone with geographical coordinates of 48° 46’56,47’’ of north latitude and 30° 14’48,51’’ of east longitude by Greenwich. Height above sea level was 245 m. The soil of the experimental field was podzolized chernozem.

In terms of rainfall, the supply of cereal crops was satisfactory. Soil samples were taken 10 days after the phase of plant development. Therefore, rainfall and average air temperature were given for the first half of each phase of plant development. There were 199.9 mm of rainfall or 28 % less than the average long-term index (277 mm) during the period of April – July 2017. There were 211.1 mm in 2018, 194.7 mm in 2019 or less by 24 % and 30 %, respectively. The distribution of rainfall during the plant development of wheat plants was different. The supply of soft wheat plants with water in 2017 and 2018 was higher than in 2019 (Table 1). 2017–2018 were better for spelt wheat, as there were 23.3 to 40.5 mm of rainfalls during the period of stem elongation – milk ripeness of the grain. In 2019, 53.4 mm of rainfall fell only in the earing phase, and 12.6–16.3 mm in other phases of plant development. The beginning of the vegetation period in 2017–2018 was sufficiently supplied with water for intermediate wheatgrass and 22.3–53.1 mm of rainfall fell during the entire vegetation period in 2019.

Table 1

Weather conditions of the first half of the development phase of different cereal crops plants

Indicator	Date of phase beginning		
	Stem elongation	Earing	Milk ripeness of grain
2017			
Kalancha	April 15	May 20	June 18
Rainfall, mm[1]	*13.7*	*23.1*	*9.2*
Temperature, ºC[2]	*10.6*	*19.2*	*22.0*
Zoria Ukrainy	May 01	June 02	June 13
Rainfall, mm[1]	*23.3*	*24.5*	*30.4*
Temperature, ºC[2]	*14.2*	*19.2*	*18.8*
Kernza	May 10	June 03	June 15
Khors	May 10	June 04	June 17
Rainfall, mm[1]	*20.4*	*30.4*	*9.2*
Temperature, ºC[2]	*12.7*	*19.2*	*22.0*
2018			
Kalancha	April 10	May 17	June 05
Rainfall, mm[1]	*17.4*	*17.5*	*32.1*
Temperature, ºC[2]	*14.8*	*15.6*	*19.3*
Zoria Ukrainy	April 26	June 06	June 21
Rainfall, mm[1]	*35.7*	*32.6*	*40.5*
Temperature, ºC[2]	*19.8*	*19.6*	*22.1*
Kernza	April 05	May 24	June 03
Khors	April 07	May 26	June 05
Rainfall, mm[1]	*43.8*	*9.8*	*32.1*
Temperature, ºC[2]	*14.8*	*18.4*	*22.1*
2019			
Kalancha	April 25	May 22	June 03
Rainfall, mm[1]	*5.4*	*23.0*	*0.4*
Temperature, ºC[2]	*9.2*	*12.4*	*12.8*
Zoria Ukrainy	May 05	June 08	June 23
Rainfall, mm[1]	*12.6*	*53.4*	*16.3*
Temperature, ºC[2]	*18.7*	*24.3*	*22.3*
Kernza	April 02	May 22	June 01
Khors	April 04	May 25	June 03
Rainfall, mm[1]	*22.3*	*23.1*	*53.1*
Temperature, ºC[2]	*12.4*	*19.2*	*20.7*

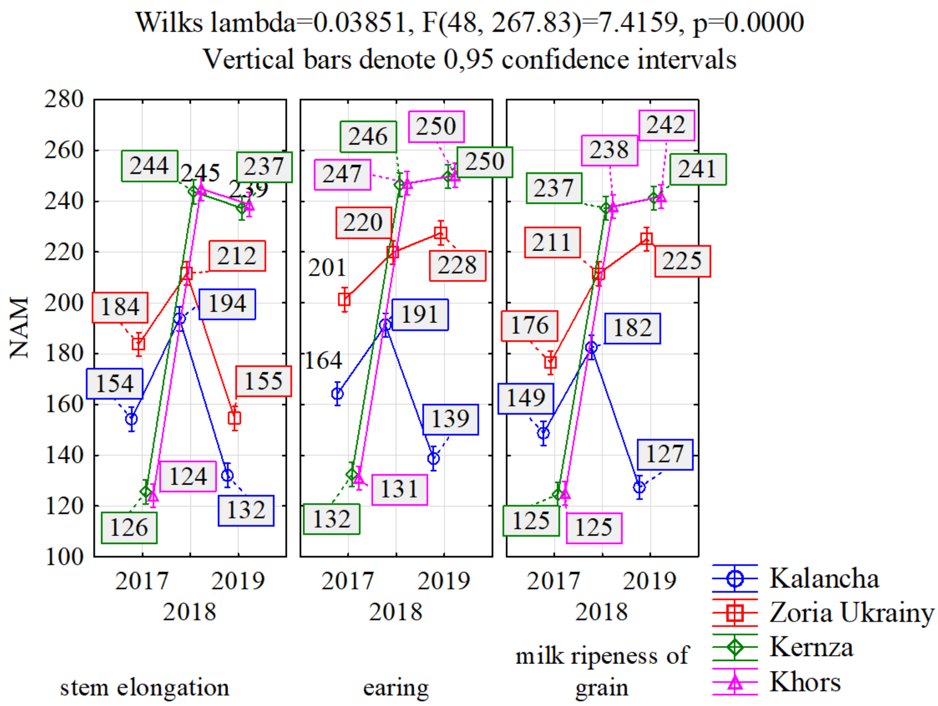
Legend: 1 – amount of rainfall; 2 – average air temperature for the first half of the phase

Air temperature also affected the development of wheat plants. The air temperature was optimal in 2017 and 2018 except spelt wheat, in which stem elongation phase took place at a temperature of 19.8 ºC which was higher than optimal (9–16 ºC) in 2018 and 2019. Temperature for soft wheat in the phases of earing (18–20 ºC) and milk ripeness of grain (22–25 ºC) was lower than optimal in 2019. It was higher than optimal in the earing phase for spelt wheat. It should be noted that the temperature was optimal in the phases of earing and milk ripeness of grain for the microbiota in the rhizosphere of cereal crops.

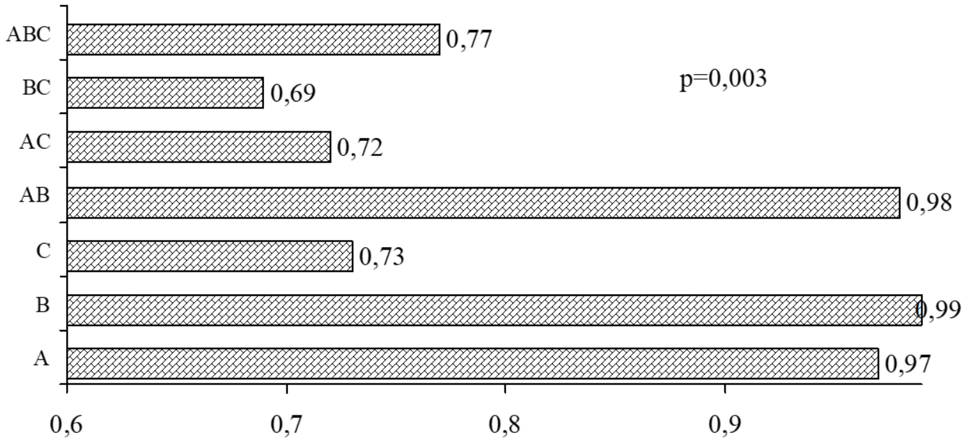
Results. The number of ammonifying microorganisms in the rhizosphere of cereal crops varied depending on a complex of factors. As a result of the analysis of variance, it was found that the number of ammonifying microorganisms in the rhizosphere of spelt wheat was significantly higher compared to soft wheat during 2017–2019 years (Fig. 1). The dynamics of the number of ammonifying microorganisms in the rhizosphere of intermediate wheatgrass was different. In the first year growing season, this figure was significantly lower than for soft wheat and spelt wheat. In the second and third years of intermediate wheatgrass plant growth, the number of ammonifying microorganisms of the soil rhizosphere was significantly higher during all stages of growth.

Better distribution of rainfall and optimal temperature in 2018 contributed to the formation of the highest number of ammonifying microorganisms in the rhizosphere of soft wheat. This indicator was 1.4–1.5 times and 1.2–1.3 times lower in the less favorable 2019 and 2017 respectively compared to 2018. Another trend was found for spelt wheat. The highest number of ammonifying microorganisms was in 2018 in the stem elongation phase due to 35.7 mm of rainfall. More rainfall during the phases of earing – milk ripeness of grain in 2018–2019 contributed to the formation of the highest number of this group of microorganisms – from 211 to 228×10^3 CFU/g of soil. This indicator was 1.1–1.2 times lower in the less favorable 2017 compared to 2019. Insufficient rainfall in the stem elongation phase in 2019 contributed to the lowest number of ammonifying microorganisms. The lowest number of this group of microorganisms was in 2017 in the rhizosphere of intermediate wheatgrass, as the development of the root system and aboveground mass was weak. This indicator was the highest in 2018 and 2019. It should be noted that the number of ammonifying microorganisms exceeded the indicator of soft wheat and spelt wheat by 1.5–1.8 times in these years of research.

Studied factors statistically significant (p≤0.05) influenced the number of ammonifying microorganisms (Fig. 2).



F i g. 1. The number of ammonifying microorganisms in the rhizosphere of cereal crops, 10^3 CFU/g of soil

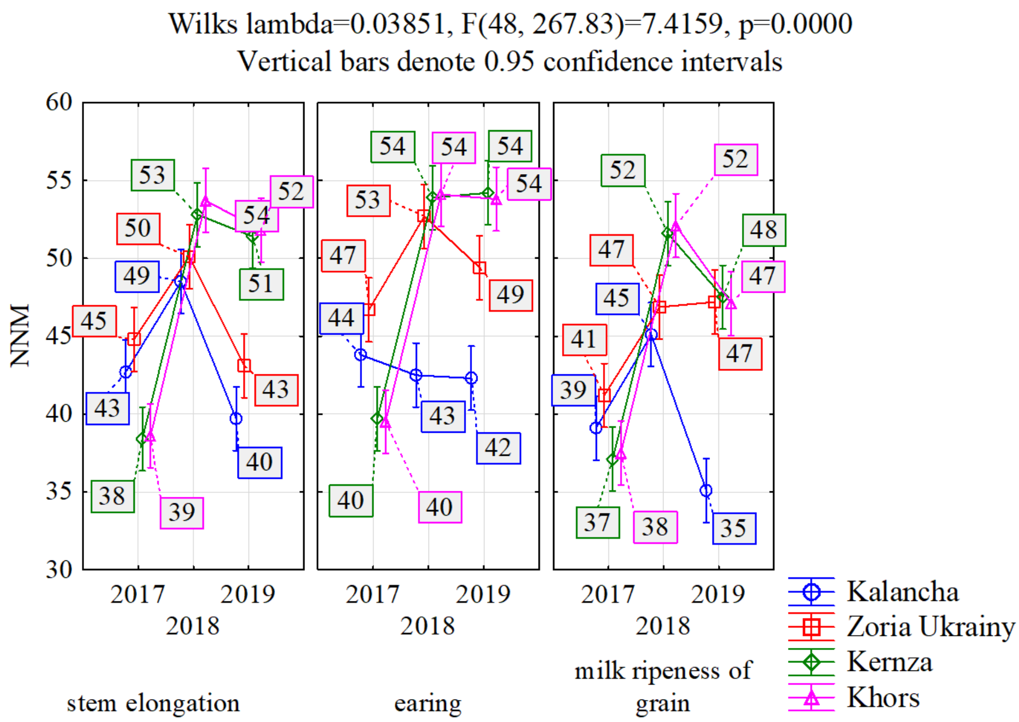


F i g. 2. The level of factors influence on the number of ammonifying microorganisms in the rhizosphere of cereal crops: A –"species of cereal crop" factor, B – "year of study" factor, C – "plant development phase" factor

The force of influence was high. It should be noted that the "species of cereal crop" and "year of study" factors influenced the number of ammonifying microorganisms the most. Obviously, there was a connection between "species of cereal crop" and "year of study". This connection with the "development phase" factor was weaker or absent, so the influence of ABC was lower compared to A and B.

In the rhizosphere of spelt wheat, the number of nitrifying microorganisms in stem elongation stage did not differ significantly from soft wheat (Fig. 3). On average, it was statistically significant ($p \leq 0.05$) that the number of nitrifying microorganisms in the rhizosphere of spelt wheat was 17–26 % higher than in soft wheat during the earing phase in 2018–2019. In the milk stage of grain, a significantly higher number of nitrifying microorganisms was only in 2019.

Intermediate wheatgrass had significantly lower number of nitrifying microorganisms in the stem elongation and earing stages compared to soft wheat. In the milk stage of grain, this figure was at the level of soft wheat. During the second and third years of intermediate wheatgrass growth, the number of nitrifying microorganisms was



F i g. 3. The number of nitrifying microorganisms in the rhizosphere of cereal crops, 10^3/g of soil

significantly (p≤0.05) higher than that of soft wheat. In the stem elongation stage, the number of nitrifying microorganisms of soil rhizosphere was 28–38 %, in the earing stage – 26–29 %, in the milk stage of grain – 16–37 % higher compared to the control (Kalancha soft wheat) depending on the year of study.

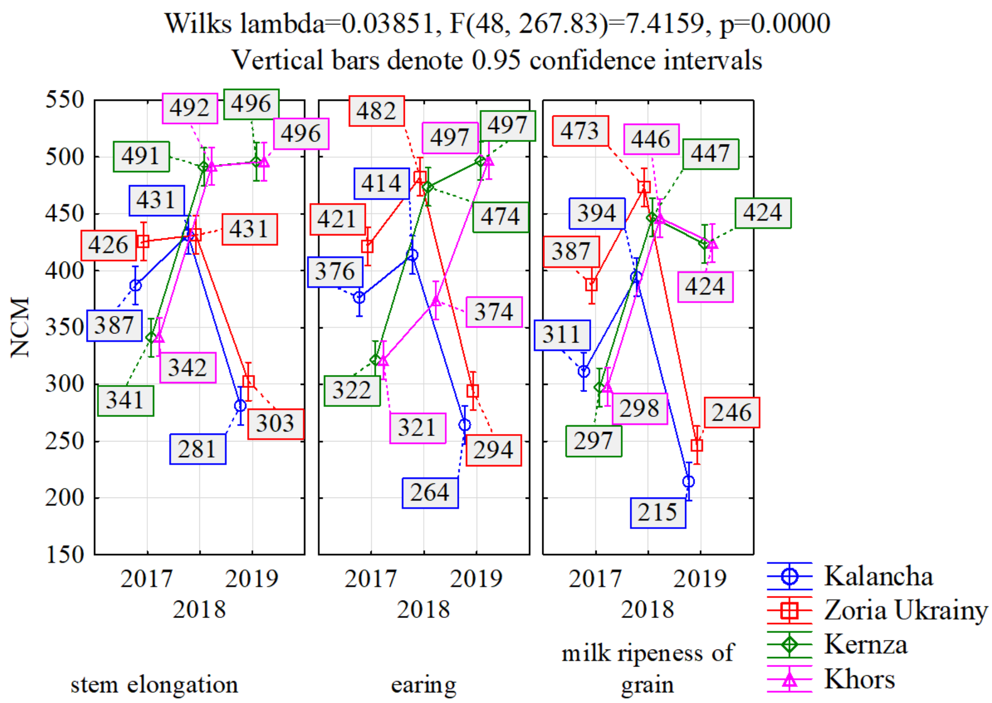
The number of nitrifying microorganisms in the rhizosphere of soft wheat and spelt wheat was the highest in a favourable 2018 year. The number index was the highest in 2018–2019 in the rhizosphere of intermediate wheatgrass.

The results of statistical processing confirmed the significantly strong influence of "species of cereal crop", "year of study" and "plant growth phase" factors on the formation of the number of nitrifying microorganisms. It should be noted that the influence of weather conditions and characteristics of the species of cereal crop and the interaction of these factors was the highest – 0.71–0.88. The "plant development phase" factor had less effect on the number of nitrifying microorganisms. Therefore, its interaction with other factors had less effect on this indicator.

The number of cellulolytic microorganisms in the rhizosphere of soft wheat and spelt wheat was the highest in the favourable 2018 year. It was the lowest in less favourable 2019. This indicator was the highest in 2018 and 2019 in intermediate wheatgrass, because the supply of plants with moisture was also high during this period.

In the stem elongation stage, the number of cellulolytic microorganisms of the soil rhizosphere of spelt wheat did not change significantly from this indicator of soft wheat (Fig. 4). However, in the earing and milk stages, the number of this group of microorganisms was significantly (p≤0.05) higher than that of soft wheat. Thus, in the earing stage of spelt wheat, the number of cellulolytic microorganisms of soil rhizosphere was 11–16 % higher compared to soft wheat depending on the year of study. In the milk stage, respectively, by 14–24 %. The dynamics of the number of cellulolytic microorganisms changed from the weather conditions of spelt wheat growing season. In 2017 and 2019, this indicator did not change significantly in stem elongation and earing stages. However, better humidity and comfort temperature for the growth of spelt wheat plants in 2018 contributed to the formation of a significantly larger number of cellulolytic microorganisms in the earing stage compared to the stem elongation one. In addition, in the milk stage, this figure did not decrease significantly compared to the earing one. In 2017 and 2019, the number of cellulolytic microorganisms in the milk stage of grain was 9 and 20 % lower, respectively, compared to the earing one.

The dynamics of the number of cellulolytic microorganisms in the rhizosphere of intermediate wheatgrass differed significantly from spelt wheat. In the first year of plants growth of intermediate



F i g. 4. The number of cellulolytic microorganisms in the rhizosphere of cereal crops, 10^3/g of soil

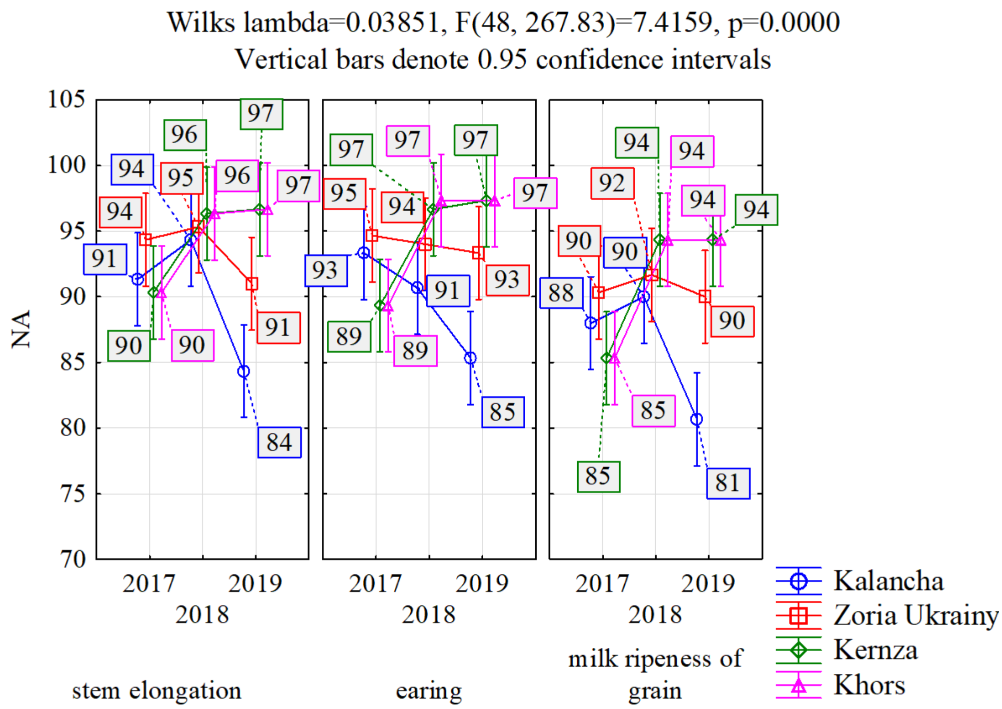
wheatgrass (2017), this figure was significantly lower in stem elongation and earing stages. During the milk stage, it was at the level of soft wheat, as the indicator of cellulolytic microorganisms in the soil rhizosphere decreased insignificantly. In the second and third years of intermediate wheatgrass growing, the number of this group of microorganisms was significantly higher than that of soft wheat. Thus, in the stem elongation stage, the number of cellulolytic microorganisms of the soil rhizosphere of intermediate wheatgrass was 14–77 %, in the earing stage 14–88, in the milk stage 13–97 % higher compared to soft wheat depending on the year of study. It should be noted that the number of this group of microorganisms was high during the growing season of intermediate wheatgrass compared to soft wheat. The number of cellulolytic microorganisms of the soil rhizosphere of intermediate wheatgrass in the earing stage was at the level of stem elongation, because the decrease was insignificant. In the milk stage only in 2019, the number of this group of microorganisms was significantly lower compared to the earing one.

Thus, it could be affirmed that the number of cellulolytic microorganisms significantly depended on the studied factors. It should be noted that there was a stronger connection between A and B factors compared to C factor. Therefore, the interaction of AC, AB and ABC was smaller compared to AB.

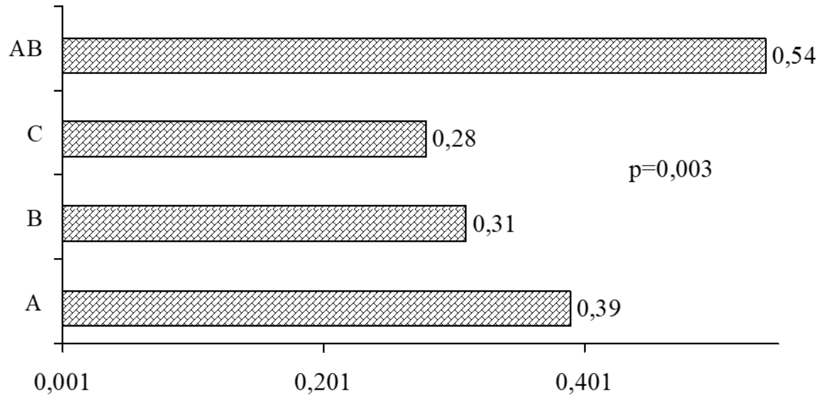
On average, the number of soil lumps overgrown with bacteria of the *Azotobacter* genus of the rhizosphere of spelt wheat and intermediate wheatgrass was significantly higher compared to soft wheat over three years of research (Fig. 5). The number of overgrown soil lumps by bacteria of the *Azotobacter* genus almost did not change from the plant development phase in the rhizosphere of all cereal crops. The number of overgrown soil lumps of *Azotobacter* over the years of research changed significantly depending on the amount of rainfall during the growth of cereal crops. It should be noted that the number of overgrown soil lumps of this group of microorganisms was the highest in the rhizosphere of intermediate wheatgrass in 2018 and 2019.

Reliable and strong influence of three factors on the number of overgrown lumps of soil by bacteria of the *Azotobacter* genus was statistically confirmed (Fig. 6). The interaction of the AC, BC and ABC factors was unreliable. It should be noted that this indicator changed less compared to other ecological and trophic groups of microorganisms.

It should be noted that the number of studied microorganisms in the soil rhizosphere of intermediate wheatgrass did not change significantly depending on the variety.



F i g. 5. The number of *Azotobacter* in the rhizosphere of cereal crops, % of overgrown lumps of soil



F i g. 6. The level of factors influence on the number of bacteria of the *Azotobacter* genus in the rhizosphere of cereal crops: A – "species of cereal crop" factor, B – "year of study" factor

Discussion. It is known [12] that the number, biomass and taxonomic structure of the soil microbial complex depend on a number of factors. Lead-in of the soil into the active land use leads to significant changes in these indicators.

A high dependence of the functional structure of the soil microbiocenosis and the interaction between microorganisms of different groups on hydrothermal conditions was established. Unfavorable hydrothermal conditions had a significant effect on the functional structure of the chernozem microbiota, disturbing trophic connections between physiological groups of microorganisms. A decrease in strength or bonds breaking in the microbiocenosis was observed under elevated air temperatures and lack of or excess moisture in the soil. The soil of the natural ecosystem is characterized by balance and stability of the functional structure of the microbiocenosis as to the action of hydrothermal factors. A less stable functional structure of the soil microbiocenosis with a low number of connections and a high degree of correlation and a simplified structure of the pleiads in unfavorable weather conditions is specific for the agroecosystem [13]. It was obvious that the improvement of moisture conditions during the vegetation period of the studied crops, according to the results of our researches, contributed to the formation of a higher number of ammonifying, nitrifying, cellulolytic microorganisms in the rhizosphere of cereal crops.

The influence of plants during the vegetation period on physiological processes and the general activity of microorganisms in the soil was due to root secretions, as well as due to the root system and terrestrial parts after extinction. In turn, the living conditions and productivity of plants depended on the structure and physiological activity of the complex of soil microorganisms [14]. In the studies of scientists [15], the number of microorganisms that absorbed organic and mineral nitrogen of the soil was the largest in the earing phase of winter wheat. It decreased in the following phases of development of winter wheat plants. The amount of root secretions depended on the growth of vegetative mass. This period in wheat was in the earing phase. Therefore, the maximum number of microorganisms (ammonifying, nitrifying, cellulolytic) in the soil of the rhizosphere of soft wheat and spelt wheat was in the earing phase. The greater number of which in spelt wheat was due to the higher number of root secretions.

Intermediate wheatgrass in the first year of the vegetation period formed a small aboveground mass and root system. As a result, the number of root secretions was probably smaller and as a result the number of microorganisms of different ecological and trophic groups was the lowest. Intermediate wheatgrass plants formed a larger root system, so the number of ammonifying, nitrifying, cellulolytic microorganisms was the highest compared to soft wheat after the first year of the vegetation period. This was confirmed by the results of researches by other scientists [16].

Conclusions. The formation of rhizosphere microbiota of spelt wheat and intermediate wheatgrass was first analyzed under the conditions of the Right-Bank forest-steppe of Ukraine. The number of main groups of microorganisms in the rhizosphere of these crops has been found to be significantly different from that of soft wheat. In the soil rhizosphere of spelt wheat, significantly more ammonifying and cellulolytic microorganisms are formed compared to soft wheat. The conducted studies indicate the feasibility of growing and use of spelt wheat in breeding programs to create varieties of soft wheat with higher microbiological activity. The total count of nitrifying and the number of soil lumps covered with bacteria of *Azotobacter* genus did not change compared to soft wheat.

The microbiota of the rhizosphere of intermediate wheatgrass reached the maximum development in the second year of cultivation. The number of ammonifying, nitrifying and cellulolytic microorganisms of soil rhizosphere of intermediate wheatgrass was significantly higher compared to soft wheat during all growth stages. The microbiota number of the rhizosphere of intermediate wheatgrass in the 2–3 year of cultivation was more resistant to adverse environmental factors compared to soft wheat. The soil microbiota of the rhizosphere did not change much depending on the phase of plant development during the vegetation period of cereal crops (spelt wheat, intermediate wheatgrass). The conducted statistical analysis showed that the influence of "species of cereal crop" and "year of study" factors had the greatest impact on the number of ammonifying, nitrifying and cellulolytic microorganisms. The conducted studies confirm the practical application of intermediate wheatgrass to preserve and increase soil fertility. Intermediate wheatgrass can be grown for up to three years in one field, as microbiological activity reaches its maximum development.

МІКРОБІОТА РИЗОСФЕРИ ЗЕРНОВИХ КУЛЬТУР

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Резюме

Основними напрямками сільського господарства є виробництво високоякісної продукції, а відновлення родючості ґрунту з використанням залуження багаторічними злаковими культурами є пріоритетним завданням в стратегії ООН. Нині зерно пшениці спельти використовують для виробництва високоякісних продуктів харчування. Пирій середній – перспективна культура для залуження. Одним із елементів біологізації є вплив вирощування сільськогосподарських культур на мікробіоту ризосфери ґрунту. Дослідження чисельності мікробіоти ризосфери ґрунту пшениці спельти і пирію середнього залишається недостатньо вивченим. Актуальним є вивчення впливу вирощування пшениці спельти і пирію середнього на формування мікробіоти їх ризосфери, що є значущим для еколого-функціональної характеристики ґрунту. **Мета.** Дослідити в динаміці чисельність окремих груп мікробіоти ризосфери злакових культур (пшениця м'яка, пшениця спельта, пирій середній) залежно від погодних умов і фази розвитку рослин. **Методи.** У роботі використано класичні мікробіологічні, статистичні методи. Зокрема, дослідження чисельності мікроорганізмів різних еколого-трофічних груп (амоніфікувальних, нітрифікувальних, целюлозолітичних і азотфіксувальних) проводили згідно загальноприйнятих у ґрунтовій мікробіології методик. Мікробіоту ґрунту визначали у ризосфері різних видів пшениці (м'яка – сорт Каланча, спельта – сорт Зоря України) та пирію середнього – Kernza і Хорс. Зразки ґрунту для досліджень відбирали у фазах виходу рослин у трубку, колосіння та молочної стиглості зерна. Достовірність впливу чинників встановлювали за величиною рівня ймовірності «р», який розраховували за допомогою програми STATISTICA 8. **Результати.** Встановлено, що чисельність основних груп мікроорганізмів ризосфери спельти і пирію середнього значно відрізняється від пшениці м'якої. У ризосферному ґрунті пшениці спельти розвивається достовірно більше амоніфікувальних і целюлозолітичних мікроорганізмів порівняно з пшеницею м'якою. Так, у фазі колосіння пшениці спельти чисельність целюлозолітичних мікроорганізмів ризосфери ґрунту була на 11–16 % більшою порівняно з пшеницею м'якою залежно від року дослідження. Чисельність нітрифікувальних і кількість оброслих грудочок ґрунту бактеріями роду *Azotobacter* не змінювалась порівняно з пшеницею м'якою. Чисельність мікробіоти ризосфери пирію середнього на 2–3 рік вирощування була стійкішою до несприятливих чинників навколишнього природного середовища порівняно з пшеницею м'якою. Так, чисельність целюлозолітичних мікроорганізмів ризосфери ґрунту пирію середнього у фазі виходу у трубку була на 14–77 %, у фазі колосіння – на 14–88 %, у фазі молочної стиглості зерна – на 13–97 % більше порівняно з пшеницею м'якою залежно від року дослідження. Упродовж вегетаційного періоду пшениці спельти і пирію середнього мікробіота ґрунту ризосфери майже не змінювалась залежно від фази розвитку рослин. Проведений статистичний аналіз свідчить про те, що чинники «вид злакової культури» і «рік дослідження» найбільше впливали на чисельність амоніфікувальних, нітрифікувальних і целюлозолітичних мікроорганізмів. **Висновки.** Вперше в умовах Правобережного Лісостепу України проаналізовано формування мікробіоти ризосфери пшениці спельти і пирію середнього. Проведені дослідження свідчать про доцільність вирощування пшениці спельти і її застосування в селекційних програмах для створення сортів пшениці м'якої з вищою мікробіологічною активністю ризосферного ґрунту. Мікробіота ризосфери пирію середнього максимального розвитку досягала на другий рік вирощування. Чисельність амоніфікувальних, нітрифікувальних і целюлозолітичних мікроорганізмів ризосфери пирію середнього була достовірно більша порівняно з пшеницею м'якою впродовж усіх фаз розвитку на другий та третій роки вирощування. Проведені дослідження підтверджують практичне застосування пирію середнього для збереження та підвищення родючості ґрунту. Пирій середній можна вирощувати до трьох років на одному полі, оскільки мікробіологічна активність при цьому досягає максимального розвитку.

Ключові слова: мікробіота, амоніфікувальні, нітрифікувальні, целюлозолітичні мікроорганізми, *Azotobacter*, ризосфера, пшениця м'яка, пшениця спельта, пирій середній.

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