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INFLUENCE OF TILLAGE ON CELLULOLYTIC ACTIVITY IN VARIOUS AGROECOSYSTEMS

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Abstract. *The soil also represents a habitat for various organisms, which have a determining role in its functioning and evolution, in this way the soil is defined as an active biological system, with multiple functions, being indispensable for maintaining life and ecological balance. Due to its heterogeneous structure and the variability of physicochemical conditions, the soil shelters complex communities characterized by significant taxonomic and functional diversity. Soil microorganisms are an essential component of pedological and geoecological systems, playing a fundamental role in maintaining fertility, ecosystem functionality and environmental stability. They include bacteria, fungi, actinomycetes, algae and protozoa, which actively participate in biochemical processes in the soil. The density, diversity, and composition of soil microbiota depend on a set of factors: depth (determining oxygen penetration); soil structure; mineral composition; amount of organic matter (available food), temperature, moisture, and vegetation (involved in complex interactions with local microbiota). The lucerne variant indicates high cellulolytic activity, where litter decomposition, expressed as % of initial mass, amounted to 82.4% for the May–June period. Cellulolytic activity shows lower values for the June–July period compared to May–June, the reason being higher temperatures of 25–30 ºC and lower precipitation compared to May–June. They ensure nutrient recycling, maintain fertility and contribute to environmental stability. In the context of sustainable agriculture and environmental protection, the conservation of microbial biodiversity is a strategic priority.*

Keywords: *soil; microorganisms; cellulolytic activity*

INTRODUCTION

Soil is the result of long-term historical processes, formed under the influence of natural factors: rock, climate, vegetation, topography, age of the soil and human activities, having a vertical structure, formed by genetic horizons that differ in morphology, the study of which requires special methods.

Each terrestrial ecosystem, each biocenosis in principle conditions and contributes to the formation of a genetic unit of soil (URSU A., 2005).

Throughout history, soil was a valued object, just like other riches and objects (HERODOTUS, 1972), the Romans evaluated soils according to color - white, black, brown, etc., mineral composition - calcareous, sandy, etc., degree of humidity - dry, wet, etc. (CATO, VARON, COLUMELLA, PLINY. M. L. V. 137. 300).

The Republic of Moldova does not have substantial natural wealth, and the economy and well-being of the population is largely conditioned by the main natural wealth - soil resources (URSU A., 2011), important for food security and which must have fertility, by monitoring different soil fertility elements when applying various agricultural systems, mention: MARINCA C., ET AL., 2009; JIGĂU GH., 2009; ANDRIEȘ S., 2009; BOINCEAN B., 2009; BOINCEAN B., STADNIC ST., 2017; ANDRIUCĂ V. ET AL., 2017; MELNIC R., 2017; LEAH T., 2017; ANDRIES S., 2003 ANDRIES S., 2017 and others, including a satisfactory health status determined by several indicators (KOZHEVIN, P.A., ANDREEVA, O.A., PRAVDIN, V.G. 2013; FIERER, N., WOOD, S.A., DE MESQUITAC.P.B. 2021; KOZHEVIN, P.A. 2023; KOZHEVIN, P.A.,

ZHERBAK, I.S., MASLOVA, O.A. 2017; LEHMANN, J., DDEBORAH., A BOSSIO, D., KOGEL-KNABNER, I. ET AL. 2020; LUDWIG, M., WILMES, P., SCHRADER, S. 2018).

The role of the biological component of the soil is essential. The diversity of biomass, determined by the variety of plant species and organisms of the soil fauna, directly influences the chemical composition, physical and biological properties of the soil, including burrowing, producing coprolites, such as earthworms (URSU A., 2007; АБАТУРОВ B.A., 1976; MIHUT C. ET AL., 2024), thus the soil represents a vital environment, ensuring multiple biospheric missions and is considered an indispensable component in the existence of life (КОВДА V. A., 1985).

Soil is an excellent medium for microbial growth, as demonstrated by its abundance and diversity. Due to its heterogeneity, this natural medium contains microbial populations with very different biological and biochemical characteristics, establishing particularly complex relationships among them. The soil micro-population consists of bacteria (eubacteria, actinomycetes, cyanobacteria), microfungi, algae, protozoa, and others.

The presence of microorganisms in soil is mainly affected by seasonal environmental conditions. Those organisms that permanently live in the soil adapt to the specific seasonal conditions. Seasonal soil conditions largely depend on soil type (its texture) and stage of development. These specific soil conditions, combined with the role of environmental factors, make a decisive contribution to understanding soil population activity and structure (PAMFIL, D.; HENEGARIU, O. 1996; MELNIC, R.; MACRII L.; POPA O., 2018).

The distribution of microorganisms along the soil profile is mainly influenced by organic matter supply. According to various previous studies, the distribution of microorganisms corresponds to the humus content of soil layers, with the highest number of microorganisms found in the organic surface layer, and their number decreasing further with depth. Algae are usually concentrated in the top 5 cm of soil, especially at the surface. Fungi show a very evident relationship with the distribution of organic matter. Oligotrophic bacteria from the genus *Lipomyces* and common yeast groups live in deeper layers of mineral soil. Protozoa are usually more abundant in the upper soil layers. Plant roots have a major influence on the distribution and movement of soil organisms, as they are sources of organic matter and harbor many more microorganisms living on their surface compared to the surrounding soil (MACRII, L.; MELNIC, R.; COJOCARU, O.; POPA, O., 2019; MELNIC, R. 2016; MELNIC, R., COJOCARU, O., POPA, O., 2017; MELNIC, R., 2018).

Soil microorganisms are characterized by two categories of biochemical processes with multiple physicochemical, biological, and agricultural consequences: degradation processes (ammonification, fermentation, etc.), which release minerals from organic matter, making them available to plants; synthetic processes, which create an input of nutrients in the soil, especially in organic form, influencing soil physicochemical state and fertility (ANDRIUCĂ, V.; MELNIC, R., 2023; KISS, Ş, 1975; ŞTEFANIC, H.; SĂNDOIU, I.; GHEORGHIŢĂ, N., 2006; VORISEK, K.. 2001).

The purpose of this research was to study cellulolytic activity in various agroecosystems under conventional tillage (plowing) and conservation tillage (No-till) in Plop, Dondușeni District.

MATERIALS AND METHODS

The research objects were various agroecosystems and tillage technologies reflecting the level of anthropogenic impact on soil quality within GȚ Agro Panfil in Plop, Dondușeni District, located in the southeastern part of the Northern Moldavian Plateau. The area belongs to zone I of podzolic and leached chernozems, grey forest soils of the forest-steppe of the Northern Moldavian Plateau.

For the study of climatic factors, data from the platform https://www.meteoblue.com were used.

Cellulolytic activity was investigated in agroecosystems under conventional tillage and conservation tillage (No-till) and was assessed according to Table 1. (МИШУСТИН, Е., ЕМЦЕВ, В., 1978).

Table 1.

Value classes of cellulolytic activity on chernozems

Cellulolytic activity (%)	Index level
< 36	Very low
36-52	Low
52-68	Medium
68-84	High
> 84	Very big

RESULTS AND DISCUSSION

According to the agroclimatic zoning of Moldova, the territory of Plop (UAT) belongs to the climatic region 1A, which is characterized by a moderately continental climate, with a short and relatively mild winter, and a long, hot summer. The sum of active temperatures is 2750–2850°C, and the duration of the active vegetation period is 165–175 days. The annual mean temperature is +8°C, with an absolute minimum of –34°C and a maximum of +39°C. The annual precipitation is 490–510 mm, but in drier years it may amount to only about 60–70% of the norm, sometimes even less.

According to the data from the three months (May–June, July) of 2025, July recorded the highest precipitation (47 mm), while August had the lowest, and the highest temperatures were registered in July and August (Figure 1). The average monthly temperature in July was 1.4°C higher compared to the average of the last 30 years (Figure 2), and the highest precipitation was registered in May, being 82 mm higher than the multiannual average for the last 30 years (https://www.meteoblue.com) (Figure 3).

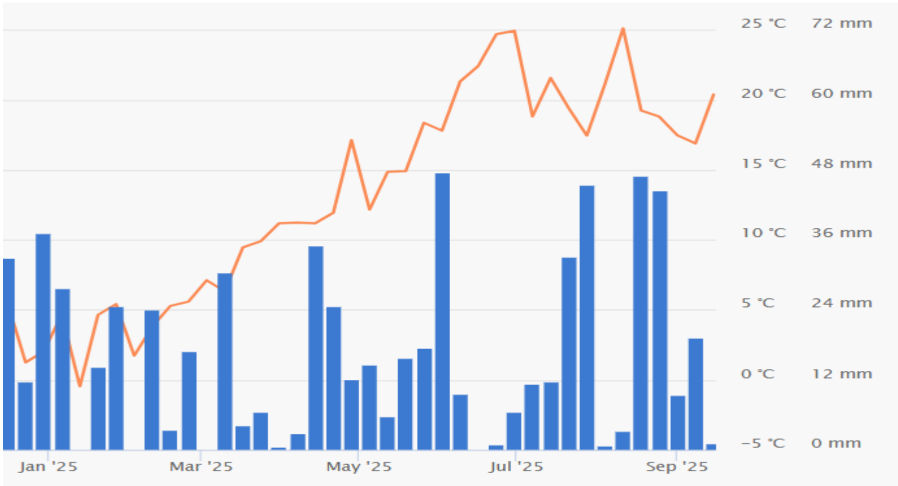

Figure 1. Precipitation (mm) and average monthly temperature, Dondușeni District

One of the main factors determining the presence and activity of microorganisms in the soil is the energy source. Unlike plants and algae, where energy is never a limiting factor due to their ability to utilize light energy, for bacteria and fungi the main growth-limiting factor is the lack of food, in other words, the lack of convenient energy sources (ANDRIUCĂ, V.; MELNIC, R., 2023; KISS, Ş, 1975; ŞTEFANIC, H.; SĂNDOIU, I.; GHEORGHIŢĂ, N., 2006; VORISEK, K., 2001).

The diversity of soil microorganisms allows cellulose to decompose under a wide range of soil conditions: acidic or alkaline pH, lose or compacted soil, and varying moisture and temperature levels. The microorganisms responsible for cellulose decomposition are specific: under aerobic conditions, decomposition is carried out by actinomycetes and aerobic fungi, while under anaerobic conditions it is performed by mesophilic and thermophilic bacteria.

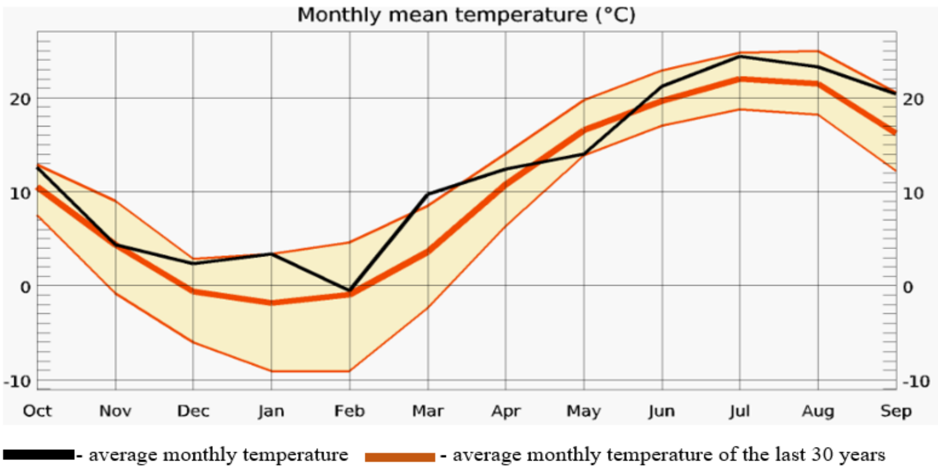

Figure 2. Temperature (°C), Dondușeni District

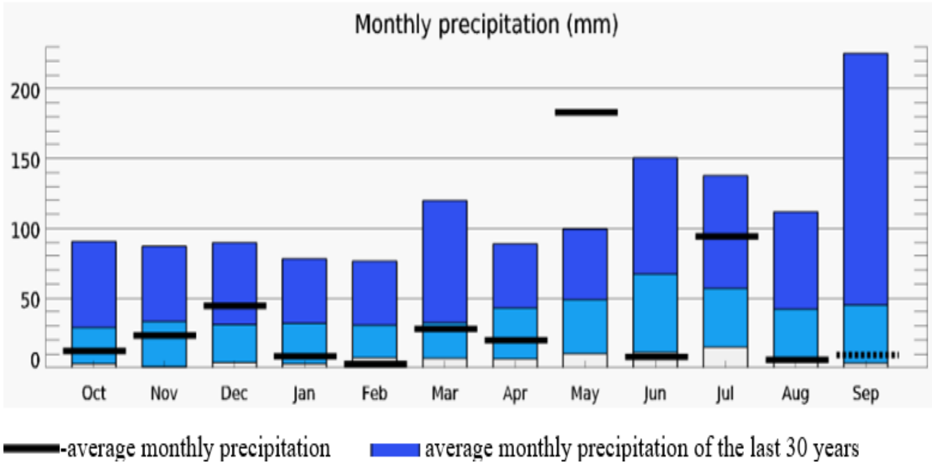

Figure 3. Precipitation (mm), Dondușeni District

Under favorable climatic conditions, the soil environment becomes aerobic, and cellulose decomposition occurs slowly, but it stops completely under high temperatures and drought. The most common aerobic microorganisms decomposing cellulose belong to the genera *Cytophaga* and *Sparasytophaga*; among myxobacteria, the genera *Myxococcus*, *Sorangium*, and *Polyangium* are involved (ALCAMO, I., 2003; GÎRLA, D., CAZMALÎ, N., 2013; MIHUSTIN, E., VASILEVA, O. 1945; MULLER, G., 1968).

Cellulolytic activity was studied in the maize agrocenoses for grain under conventional tillage, conservation tillage (No-till), and lucerne (fig. 4), during May–June (Table 2) and June–July (Table 3).

Figure 4. Bottles extracted from the soil

Table 2.

Cellulolytic activity (%) in various agrocenoses depending on tillage, May–June 2025, GȚ Agro Panfil, Plop, Dondușeni District (25.05.25)

Depth, cm	Placement of litter bag	Litter decomposition, % of initial mass	Assessment of cellulolytic activity on chernozems (Mişustin E. method)	Mean
Maize, No-till (T-1)				
0-10	In-row	74,2	high	74,20
	Between rows	71,5	high	
	In-row	76,9	high	
10-20	In-row	69,5	high	67,57
	Between rows	62,8	medium	
	In-row	70,4	high	
20-30	In-row	67,2	medium	64,03
	Between rows	61,8	medium	
	In-row	63,1	medium	
Lucerne (T-3)				
0-10		81,8	high	81,8
10-20		82,4	high	82,4
20-30		78,3	high	78,3
Maize, Plowing (T-4)				
0-10	In-row	78,5	high	75,70
	Between rows	73,0	high	
	In-row	75,6	high	
10-20	In-row	72,6	high	72,23
	Between rows	69,3	high	
	In-row	74,8	high	
20-30	In-row	71,5	high	70,47
	Between rows	69,7	high	
	In-row	70,2	high	

Table 3.

Cellulolytic activity (%) in various agrocenoses depending on tillage, June – July 2025, GȚ Agro Panfil, Plop, Dondușeni District (29.06.25)

Depth, cm	Placement of litter bag	Litter decomposition, % of initial mass	Assessment of cellulolytic activity on chernozems (Mişustin E. method)	Mean
Maize, No-till (T-1)				
0-10	In-row	54,2	medium	49,60
	Between rows	44,7	small	
	In-row	49,9	small	
10-20	In-row	51,6	small	51,33
	Between rows	49,4	small	
	In-row	53,0	medium	
20-30	In-row	46,3	small	42,13
	Between rows	38,9	small	
	In-row	41,2	small	
Lucerne (T-3)				
0-10		41,3	small	41,3
10-20		50,2	small	50,2
20-30		53,7	medium	53,7
Maize, Plowing (T-4)				
0-10	In-row	71,3	high	70,43
	Between rows	65,8	medium	

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	In-row	74,2	high	
10-20	In-row	73,4	high	72,40
	Between rows	69,6	high	
	In-row	74,2	high	
20-30	In-row	66,7	medium	65,97
	Between rows	60,2	medium	
	In-row	71,0	high	

According to the data, cellulolytic activity in May–June was higher compared to June–July. In the maize (No-till) variant, fabric decomposition (%) relative to initial mass for the 0–30 cm layer averaged 68.60% during May–June, compared with 47.69% in June–July, a decrease of 20.9%. In the lucerne variant, cellulolytic activity decreased considerably, down to 48.40%. In the maize for grain variant, cellulolytic activity decreased only slightly, recording 69.60% in June–July compared to 72.80% in May–June (fig. 5).

Moreover, higher microbial activity was observed on the plant rows. The rhizosphere is the soil zone influenced by plant roots, which release simple and complex sugars, growth regulators, amino acids, enzymes, etc., and is the site of intense microbial activity.

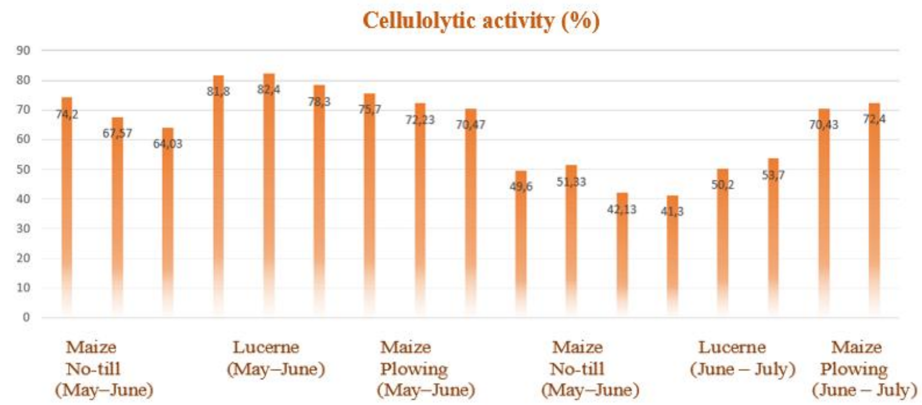

Figure 5. Cellulolytic activity, PLOP DONDUȘENI (2025)

Microbial diversity is crucial for maintaining soil quality and enhancing plant growth. When plants are grown in soils rich in diverse microbial communities, they become healthier and more resistant to stress.

CONCLUSIONS

Cellulose-decomposing microorganisms act under aerobic conditions, where decomposition is performed by actinomycetes and aerobic fungi, while under anaerobic conditions decomposition is carried out by mesophilic and thermophilic bacteria. Cellulose degradation occurs slowly under optimal climatic conditions.

The fungi and bacteria responsible for cellulose decomposition in soil belong mainly to the group of mesophilic bacteria, with an optimum activity temperature of 25–30°C. When water saturation exceeds 50% of field capacity, bacteria decompose cellulose to a greater extent, while fungal activity decreases.

In order to provide optimal living conditions for soil microorganisms, the soil must meet specific chemical and physiological requirements, which may be achieved either through natural processes or through human management practices such as soil care and improvement (CHESWORTH, W., 2008).

BIBLIOGRAFIE

ABATUROV B.A., 1976 - Soil-forming role of animals in the biosphere. Biosphere and soil. Moscow, 1976. 321 p.

ALCAMO, I., 2003 - Microbes and society, an introduction to microbiology, Jones and Bartlett Publishers. Boston, 2003. pp. 294-315.

ANDRIEȘ, S., 2017 -Properties and functions of soil organic matter and measures for the preservation of fertility. In: Soil and fertilizers in contemporary agriculture: conf. șt. internal. 120 years since the birth of academician Ion Dicusar, September 6-7, 2017. Chisinau: CEP USM, 2017, pp. 22-27. ISBN 978-9975-71-9278.

ANDRIEȘ, S., 2023 - State of the land fund, protection measures and rational use. In: The soil - one of the main problems of the 21st century. Proceedings of the International Scientific-Practical Conference. Chisinau, August 7, 2003. Chisinau: Pontos, 2003. pp. 59-75. ISBN 9975-902-84-7.

ANDRIUCĂ, V.; MELNIC, R. ET AL., 2023 - Comparative assessment of the suitability of some soils in the Republic of Moldova regarding the cultivation of sea buckthorn. In: Modern trends in the agricultural higher education. International Scientific Symposium. Book of abstracts. Chișinău, 2023. pp. 34.

BOINCEAN, B., 2009 - Modern Agriculture and the Necessity of Its Sustainable Development in the Republic of Moldova. In: Agriculture of Moldova. 2009, no. 9 – 10. 12 p. ISSN 0582-5229.

BOINCEAN, B.; STADNIC, S., 2017 - Crop yield according to fertilization systems on the typical chernozem of the Stick Steppe. In: Research and management of soil resources. Materials of the scientific conference with international participation of the National Society of Soil Science of Moldova. September 8-9, 2017. Chisinau: CEP USM, 2017. pp. 151-165. ISBN 978-9975-71-931-5.

CATO, VARON, COLUMELLA, PLINY. - About agriculture. M. L. V. 137. 300 p. (In Russian)

CHESWORTH, W., 2008 - Encyclopedia of soil science. Published by Springer. Dordrecht, 2008. – 902 p.

Classification of soils of the Republic of Moldova. Chisinau: SNMSS, 1999. 38 p.

FIERER, N., WOOD, S.A., DE MESQUITAC, P.B. 2021 - How microbes can, and cannot, be used to assess soil health. În: Soil Biology and Biochemistry. 2021, vol. 153. ISSN:00380717.

GÎRLA, D., CAZMALÎ, N., 2013 - Methodical indications regarding the evaluation of soil status in different agroecosystems based on microbiological indices. UASM Publishing House. Chisinau, 2013. pp. 11-13.

HERODOTUS. HISTORY IN NINE BOOKS., 1972 - Leningrad: Nauka, 1972. 454 p. (In Russian)

https://www.meteoblue.com/ro

JIGĂU, GH., 2015 - Evolution of the soils of the Republic of Moldova and the regional model of implementation of the conservative agricultural system. In: Conservative agriculture: summary. To the reports of Conf. şt. - internship with int. participation, 25 Feb., 2015. Chisinau: ed. "Bons Offices", 2015. pp. 12. ISBN 978-9975-80-940-5.

KISS, Ș., 1975 - General Microbiology. II-Lito Univ. Cluj-Napoca, 1975. pp. 74.

KOVDA, V. A., 1985 - The role and functions of soil cover in the earth's biosphere. Pushchino, 1985. 82 p. (In Russian)

KOZHEVIN, P.A., ZHERBAK, I.S., MASLOVA, O.A., 2017 - The role of soil microorganisms in environmental and food security. In: Moscow University Soil Science Bulletin. 2017, vol. 72, no. 5. ISSN 1934-7928.

LEAH, T., 2015 - Priority research in conservative agriculture of the Republic of Moldova. In: Conservative agriculture: summary. Reports of Scientific Associate Professor - Practice with Int. Participation, 25 Feb., 2015. Chisinau: ed. "Bons Offices", 2015. pp. 16. ISBN 978-9975-80-940-5.

LEHMANN, J., DDEBORAH., A BOSSIO, D., KOGEL-KNABNER, I. ET AL., 2020 - The concept and future prospects of soil health. In: Nature Reviews Earth & Environment. 2020, vol. 1, no.10. ISSN 2662-138X.

LUDWIG, M., WILMES, P., SCHRADER, S., 2018 - Measuring soil sustainability via soil resilience. In: Science of the Total Environment. 2018, vol. 626. ISSN 1879-1026.

MACRII, L.; MELNIC, R.; COJOCARU, O.; POPA, O., 2019 - The cellulolytic activity depending on soil tillage and influence of forest stripunder winter wheat agrocoenoses. In: Scientific Papers. Series A. Agronomy, Vol. LXII, No. 1. București, 2019. ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785. pp. 63-68.

MARINCA, C. ET AL., 2009 - Soil and fertility. The relationship with the agricultural systems in Banat. Timişoara, 2009. 628 p.

MELNIC, R., 2016 - Cellulolytic activity evaluation of th esoil of various agroecosystems. In: Life Sciences a challengeto the future. International scientific Congress 20-22 October 2016. Iaşi, România. Programe Book of Abstracts. p. 58.

MELNIC, R., 2018 - Influence of environmental factors, soil tillage on cellulolytic activity in different agro-ecosystems. Uluslararası Tarım Kongresi Internatıonal Agrıculture Congress. 3-6 Mayıs, 2018, Komrat/ Gagauzya/ Moldova. p. 232.

MELNIC, R., COJOCARU, O., POPA, O., 2017 - The influence on the soil of physical activity index cellulolytic autumn wheat under agrocoenoses. In: Revista Botanică. Numărul 1(14). Chișinău, 2017. pp. 133-137.

MELNIC, R.; MACRII L.; POPA O., 2018 - Evaluation of the cellulolytic activity depending on soil tillage system and meteorological conditions under sunflower agrocoenoses. In: Scientific Papers. Series A. Agronomy, Vol. LXI, No. 2, 2018. ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785. Pp. 40-43.

MIHUSTIN, E., VASILEVA, O., 1945 - Warmeliebende Mikroorganismen des Bodens (russ). Mikrobiologija 1945. pp. 14.

MIHUȚ, C., NIȚĂ, L. DUMA COPCEA, A., RINOVETZ, A., 2024 - Assessment of the productive capacity of agricultural lands for their sustainable use. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 24, Issue 1, 619-626.

MISHUSTIN, E., YEMTSEV, V., 1978 - Microbiology. Iz. Kolos. Moscow, 1978. 351 p.

MULLER, G., 1968 - Soil Biology. Ed. Agro Silvica. Bucharest, 1968. pp. 28-27.

PAMFIL, D.; HENEGARIU, O., 1996 - Microbiologie, Ed. Tipo Agronomia Cluj-Napoca, 1996. pp. 113-114, 96, 41,44,91,83, 121-122.

ŞTEFANIC, H.; SĂNDOIU, I.; GHEORGHIȚĂ, N., 2006 - Biology of agricultural soils, Ed. Elisavaros, Bucharest, 2006. pp. 68.

URSU, A., 2005 - Soil and biocenosis. In: Bulletin of the Academy of Science of Moldova. Life Sciences, 2005, no. 1 (296), p. 161-167.

URSU, A., 2007 - Pedogenetic activity of some mammals. In: Ambiul ambiant, 2007, nr. 6(36), p. 3-4.

URSU, A., 2011 - Soils of Moldova. Chisinau: Ştiinţa, 2011. 324 p.

VORISEK, K., 2001 - Evaluation of soil biological activity. In: Symp. Crop science on the verge of the 21-st century-opportunities and challenges, Prague. 2001. pp.141-144.

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