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Influence of growing conditions on changes in the species composition of mycobiota of scots pine seeds

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Abstract. The species composition of Scots pine seeds collected from plantings growing in different forest conditions and selected from trees of different age groups is investigated. It is identified that the seeds most often encountered micromycete species – *Alternaria alternata*, *Cladosporium cladosporioides*, *Fusarium oxysporum*, *Mycelia sterilia*. Dominant micromycete species are identified, in particular, *Penicillium cyclopium*, *Alternaria alternata*, *Cladosporium cladosporioides*, *Fusarium sambucinum*, which are most dangerous for the development of healthy planting material. The largest number of micromycetes from seeds of plantings growing in wet (A_3) – 189 species and fresh pine barrens (A_2) – 103 micromycetes, and the smallest – fresh (B_2) and wet su-barrens (B_3), respectively 92 and 93 isolates. *Micromycetes Penicillium cyclopium*, *Alternaria alternata*, Trithothecium roseum had the highest occurrence frequency on experimental samples of Scots pine seeds selected from fresh barren plantations, and the lowest – *Mortierella alpine*, *P. canescens*, *P. lanosum*, *P. variabile*, *Fusarium sporotrichioides*. Notably, *Mycelia sterilia* (9.2%) and *Fusarium sporotrichioides* (9.6%) were most often identified on seeds selected from trees of different age groups, while the least often ones were *Alternaria alternata*, *A. tenuissima*, *Fusarium verticillioides*, *Trichothecium roseum* – 1.9%. The similarity of the species composition of mycobiota seeds selected from young and medium-aged plantings (similarity indicator – 84.2%) and medium-aged and mature ones (similarity indicator – 89.4%) was investigated. Less similarity was observed between the species composition of fungi identified on seeds selected from young and mature plantings (the similarity rate is 73.6%). The seeds of middle-aged and mature plantings were the most similar, and the seeds of young and mature ones were the least similar. Therewith, seeds selected from different age groups are different in the species composition of micromycetes (the similarity varied in the range of 73.6-89.4%)

Keywords: age groups of trees, mycobiota, type of forest conditions, micromycetes, Scots pine

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Introduction

Scots pine, like many other coniferous tree species, is naturally restored only by seed. Phytopathogenic fungi that cause seed diseases are given special attention in forestry production, since their presence on seeds, even in hundredths of a per cent of the total number of microorganisms, poses a real threat during its germination. Therefore, the study of mycobiota seeds is relevant, and its quality class is the key to the formation of stable and productive pine plantations (Bojko & Bashta, 2015). The seed quality class may decrease if the seeds are infected with pathogens (Bilaj, 1984; Bilaj, 1998). On growing trees, the seeds are protected by cone scales and, with timely harvesting, are almost not affected by pathogens from the outside. Seeds of unopened cones are 100% healthy, but have their own microflora, including pathogenic (Rozenfeld, 2005).

The wide ecological plasticity of fungi according to the method of nutrition and substantial biodiversity allows them to occupy almost all niches of the forest phytocenosis, to ensure the circulation of substances in the biocenosis. It is known that the oldest form of existence of fungi is a saprotrophic way of life, and the transition to parasitism in them occurred in the process of long-term evolutionary development (Patyka, 2007). According to the degree of parasitic activity and lifestyle, groups of fungi are distinguished, which are located at different stages of the evolutionary ladder (Bilokin, 1995).

Evidently, even in natural conditions, the species and form diversity of mycological and microbiological groups of Scots pine is directly related to the diet (all other conditions being equal). It is known that the plant selects its own myco- and micro-complex, and it is quite likely that this is due to the nutrition of the plant. Myco- and micro-organisms are characterised by selectivity to certain organic and mineral compounds, and their ratio substantially affects mycobiota (Pidoplichko, 1977; Pidoplichko, 1991).

According to the study by Sandul (2010), crops created from dark seeds in barren conditions are characterised by more intensive growth, are better adapted to growth in them, and are much more promising for reforestation and afforestation. According to Bojko & Puzrina (2015), forest conditions substantially affect the quality indicators of the seed quality class. Seeds collected in fresh su-barren plantings (B_2) had the highest germination rate (91.0±2.1%). Its germination energy was also higher (81.3±1.5%). Seeds collected from fresh and wet pine barren plantings had germination rate and germination energy indicators on average 4-15% lower than seeds, which in studies represent the conditions of fresh and wet soil. Seeds selected from plantings in wet su-barren conditions (B_3), were characterised by high germination energy (83.1±1.1%) and germination rate (89.2±1.5%). Seeds obtained from trees that grew in wet forest A_3 conditions, achieved a germination rate of 85.0±1.8% and had germination energy of 78.4±1.7%. Therewith, there was no substantial difference in seed germination rate from trees of different age groups. In particular, the germination energy of seeds selected from young plantings was 76.5±2.1%, medium-aged – 76.0±1.3%, mature – 79.3±2.1%, its germination rate – 85.0±1.8%, 85.0±1.5%, 87.5±1.8% accordingly.

Some authors, in particular, Antonova (1990), note that seeds from young trees are not inferior to seeds from older plantings. This is confirmed by the study by Reshetnik (2010), which noted that at least at a young age (up to 25 years) there is such a hereditary property. According to the results obtained by the researcher, the germination rate, germination energy, and seed mass from young Scots pine trees were higher compared to the same indicators of seeds of 100–120-year-old trees.

Naturally, the conditions from which seeds are selected substantially affect the qualitative and quantitative indicators (Bojko & Puzrina, 2015). Considering this, the studies were conducted to identify micromycetes of different forest conditions and age groups, which, according to the data, have different species composition.

The purpose of the study is to analyse the species composition of mycobiota seeds collected from plantings growing in different forest conditions and from trees of different ages.

The object of research – mycobiota of Scots pine seeds selected from seeds of different forest conditions and age groups of trees.

The subject of research – species composition of mycobiota of Scots pine seeds.

The study objectives – determine the species composition of automycobiota of Scots pine seed batches from different forest-growing conditions (fresh barren – A_2, wet barren – A_3, fresh su-barren – B_2, wet su-barren – B_3) and from trees of different ages (young, middle-aged, mature).

Materials and Methods

During the study, special scientific methods were used: mycological and phytopathological – to isolate myco- and microorganisms from seeds and further examine pathogenic, cultural, antagonistic properties.

The research material was Scots pine seeds (*Pinus sylvestris L.)*, collected in plantings of different ages (young, middle-aged, mature) and different types of forest-growing conditions (FGC) (wet barren (A_3), fresh barren (A_2), fresh su-barren (B_2), wet su-barren (B_3)).

The study was conducted in the problem laboratory "Phytopathology and Mycology" of the V.F. Peresypkin Department of Phytopathology of the National University of Life and Environmental Sciences of Ukraine.

For the study, agarised differential diagnostic nutrient media optimal for the growth and development of individual physiological groups of microorganisms were used: meat-peptone agar (MPA) – for bacteria; Czapek medium – for mycelial fungi; potato-glucose agar (PGA) – for mycelial fungi and yeast.

Scots pine seeds were disinfected with a 0.5% solution of Potassium permanganate enzyme for 20 minutes, washed with sterile tap water, after which the test material was sown on agarised nutrient media or laid out on filter paper under sterile conditions to isolate mycobiota. The crops were incubated in triple repetition at a temperature of 26-28°C for 5-7 days. Counting of colonies began 3-4 days after seeding of the test sample and performed 2-3 accounts with an interval of 1-2 days.

Results and Discussion

The largest number of micromycetes was identified on seeds collected in wet (A_3) – 189 species and fresh pine barrens (A_2) – 103 micromycetes, while the smallest was from the fresh (B_2) – 92 types and wet su-barrens (B_3) – 93 isolates (Table 1).

Table 1. Mycobiota of Scots pine seeds harvested from trees in various types of forest conditions, %

Types of micromycetes		FGC				occupancy rate, %
		fresh barren – A_2	wet barren – A_3	fresh su-barren – B_2	wet su-barren – B_3	
		occurrence frequency, %				
1	*Mortierella alpina*	3.45	–	–	–	25.0
2	*Mucor globosus*	–	5.56	3.70	–	50.0
3	*M. hiemalis*	–	5.56	–	–	25.0
4	*Rhizopus nigricans*	–	–	–	6.25	25.0
5	*Chaetomium botrychodes*	–	–	–	6.25	25.0
6	*Aspergillus niger*	–	–	7.41	–	25.0
7	*A. versicolor*	10.3	–	–	–	25.0
8	*Paecilomyces varioti*	–	11.1	–	6.25	50.0
9	*Penicillium canescens*	3.45	–	–	6.25	25.0
10	*P. cyclopium*	27.6	11.1	7.41	–	75.0
11	*P. expansum*	3.45	–	–	12.5	50.0
12	*P. funiculosum*	6.89	5.56	–	–	50.0
13	*P. lanosum*	3.45	–	–	–	25.0
14	*P. variabile*	3.45	–	3.70	–	50.0
15	*P. wortmannii*	–	–	–	6.25	25.0

Table 1. Continued

Types of micromycetes		FGC				occupancy rate, %
		fresh barren – A_2	wet barren – A_3	fresh su-barren – B_2	wet su-barren – B_3	
		occurrence frequency, %				
16	*Alternaria alternata*	10.3	–	22.2	18.7	75.0
17	*A. tenuissima*	3.45	–	–	6.25	50.0
18	*Cladosporium cladosporioides*	3.45	–	3.70	12.5	75.0
19	*C. herbarum*	–	–	3.70	–	25.0
20	*Fusarium graminearum*	–	–	3.70	–	25.0
21	*F. moniliforme*	–	5.56	3.70	–	50.0
22	*F. oxysporum*	–	–	14.8	–	25.0
23	*F. sambucinum*	3.45	5.56	7.41	–	75.0
24	*F. sporotrichioides*	3.45	–	–	–	25.0
25	*Trithothecium roseum*	10.3	27.8	–	–	50.0
26	*Gliocladium roseum*	–	16.7	7.41	–	50.0
27	*Acremonium strictum*	–	5.56		–	25.0
28	*Epicoccum nigrum*	–	–	11.1	–	25.0
29	*Mycelia sterilia*	6.89		–	12.5	50
Total number of isolates, pcs.		103	189	92	93	–

This indicator is slightly lower in fresh barren seeds (A_2) – 103 isolates, almost the same number of species was inherent in seeds selected in fresh (B_2) and wet (B_3) su-barrens.

This factor can be explained by the presence of moisture, since micromycetes choose the most favourable conditions for their development, with a sufficient amount of moisture necessary for their vital activity. The type of forest conditions (A_3) substantially differs in its quantitative and specific composition of micromycetes.

Most often, micromycete species were identified on seeds collected from different forest conditions. These are *Alternaria alternata* (occurrence frequency (OF) – 7.4-10.0%, occupancy rate (OR) – 10.0-83.3%); *Cladosporium cladosporioides* (OF – 1.7-12.5%, OR – 53.3-79.2%); *Fusarium oxysporum* (OF – 2.5-6.7%, OR – 46.7-66.7%); *Mycelia sterilia* (OF – 3.0-40.0%, OR – 33.3-83.3%).

Micromycetes had the highest occurrence frequency on experimental samples of Scots pine seeds selected from fresh barren plantations *Penicillium cyclopium* – 26.7%, *Alternaria alternata*, *Trithothecium roseum* – 10.3%, and the smallest *Mortierella alpine*, *P. canescens*, *P. lanosum*, *P. variabile*, *Fusarium sporotrichioides* – 3.45%.

For wet barren (A_3) the highest occurrence frequency was in *Trithothecium roseum* – 27.8%, *Gliocladium roseum* – 16.7%, the lowest – *Mucor globosus*, *M. hiemalis*, *Acremonium strictum*, *Penicillium funiculosum*, *Fusarium moniliforme* – 5.56%.

In the conditions of fresh su-barren the most often were *Alternaria alternata* (22.2%)*, Fusarium oxysporum* (14.8%), *Aspergillus niger*, *P. cyclopium*, *F. sambucinum*, *Gliocladium roseum* (7.41%), the least *Cladosporium cladosporioides*, *C. herbarum*, *Fusarium graminearum*, *F. moniliforme* (3.70%).

Micromycetes had the highest occurrence frequency on experimental samples of Scots pine seeds selected from fresh barren plantations *Penicillium cyclopium* – 26.7%, *Alternaria alternata*, *Trithothecium roseum* – 10.3%, and the smallest *Mortierella alpine*, *P. canescens*, *P. lanosum*, *P. variabile*, *Fusarium sporotrichioides* – 3.45%.

In the conditions of wet su-barren (B_3) the following species were characterised by the maximum occurrence frequency: *Alternaria alternata* (18.7%), *Cladosporium cladosporioides*, *Penicillium expansum* (12.5%). The species with minimum frequency indicators were: *Rhizopus nigricans*, *Chaetomium botrychodes*, *Paecilomyces varioti*, *Penicillium canescens* (6.25%).

As for the micromycete population coefficient, the dominant species were *Penicillium cyclopium, Alternaria alternata, Cladosporium cladosporioides, Fusarium sambucinum* (75% settlement rate), which are most dangerous for the development of healthy planting material.

Also very dangerous were the following species*: Trithothecium roseum*, *Gliocladium roseum*, *Fusarium moniliforme*, *Penicillium expansum*, *P. funiculosum*, *Paecilomyces varioti*, *Mucor globosus* (OR – 50%).

Consequently, forest conditions to a certain extent affect the species diversity of mycobiota components.

In all experimental versions, *Mortierella alpina* were isolated (OF varied between 1.5-13.3%, OR – 6.6-10%); *Mucor globosus* (OF – 1.5-16.7%, OR – 13.3-50.0%); *M. hiemalis* (OF was 1.3-12.5%, OR – 12.5-25%); *Rhizopus nigricans* (OF – 1.7-6.25%, OR – 6.7-25%); *Paecilomyces varioti* (OF – within 0.8-11.1%, OR – 10.0-25.0%); *P. lanosum (*OF – -3.45%, OR – 13.3-25.0%); *P. variabile* (OF – 2.1-3.45%, OR – 12.5-50.0%)*; P. wortmannii* (OF – 0.8-6.25%, OR – 13.3-25%); *Alternaria alternata* (OF – 7.4-10.0%, OR – 10.0-83.3%); *A. tenuissima* (OF – 1.9-16.7%, OR – 33.3-50.0%); *Cladosporium cladosporioides* (OF – 1.7-12.5%, OR – 53.3-79.2%); *F. oxysporum* (OF – 2.5-6.7%, OR – 46.7-66.7%)*; F. sambucinum* (OF – 4.0-6.7%, OR – 30.0-50.0%)*; F. sporotrichioides* (OF – 6.2-16.7%, OR – 16.7-60.0%); *Mycelia sterilia* (OF – 3.0-40.0%, OR – 33.3-83.3%).

In the course of the study, such an important factor as the influence of the age of plantings on the species diversity of the microbiota of Scots pine seeds was investigated. Seeds were harvested on the farm in stands of different ages of I-II classes of bonitets, which grew in conditions of fresh su-barren (Table 2). Seeds selected from different age groups are different in the species composition of micromycetes (similarity varied in the range of 73.6-89.4%).

Table 2. Occurrence frequency (OF) and occupancy rate (OR) of mycobiota Scots pine seeds from trees of different age groups, %

Types of fungi		Scots pine seeds from trees of different age groups					
		young		middle-aged		mature	
		OF, %	OR, %	OF, %	OR, %	OF, %	OR, %
1	*Mortierella alpina*	3.7	13.3	1.6	6.7	2.5	10.0
2	*Absidia glauca*	1.9	6.7	0.8	3.3	1.7	6.7
3	*Mucor globosus*	4.6	16.7	4.0	16.7	3.4	13.3
4	*M. hiemalis*	1.9	6.7	0.8	3.3	1.7	6.7
5	*Rhizopus nigricans*	1.9	6.7	2.4	10.0	1.7	6.7
6	*Chaetomium globosum*	–	–	1.6	6.7	–	–
7	*Aspergillus. flavus*	7.4	26.7	4.0	16.7	5.2	20.0
8	*A. fumigatus*	3.7	13.3	3.2	13.3	4.3	20.8
9	*A. nidulans*	1.6	13.3	4.0	16.7	4.3	20.8
10	*A. niger*	3.7	30.0	6.4	16.7	7.7	37.5
11	*A. oryzae*	8.3	20.0	3.2	13.3	4.3	20.8

Table 2. Continued

Types of fungi		Scots pine seeds from trees of different age groups					
		young		middle-aged		mature	
		OF, %	OR, %	OF, %	OR, %	OF, %	OR, %
12	*A. terreus*	5.6	13.3	2.4	10.0	5.2	25.0
13	*Paecilomyces varioti*	3.7	6.7	3.2	13.3	–	12.5
14	*Penicillium canescens*	1.9	6.7	4.0	16.7	2.5	10.0
15	*P. chrysogenum*	1.9	6.7	1.6	6.7	0.8	3.3
16	*P. cyclopium*	4.6	13.3	1.6	6.7	2.5	3.3
17	*P. expansum*	1.9	6.7	2.4	10.0	2.5	10.0
18	*P. funiculosum*	2.7	10.0	4.8	20.0	5.2	20.0
19	*P. lanosum*	3.7	13.3	4.8	20.0	5.2	20.0
20	*P. variabile*	1.9	6.7	–	–	–	–
21	*P. wortmannii*	1.9	6.7	10.0	12.5	5.2	13.3
22	*Trichoderma viride*	-	-	16.7	95.8	2.5	20.0
23	*Alternaria alternata*	1.9	6.7	10.0	83.3	3.4	10.0
24	*A. tenuissima*	1.9	6.7	16.7	50.0	3.4	13.3
25	*Cladosporium cladosporioides*	–	–	10.0	79.2	1.7	6.7
26	*C. herbarum*	–	–	–	–	1.7	6.7
27	*Fusarium verticillioides*	1.9	6.7	–	–	1.7	37.5
28	*F. oxysporum*	3.7	13.3	13.3	66.7	2.5	6.7
29	*F. sambucinum*	2.7	10.0	6.7	50.0	1.7	10.0
30	*F. sporotrichioides*	9.6	16.7	16.7	66.7	2.5	10.0
31	*Mycelia sterilia*	9.2	33.3	40.0	83.3	5.0	23.3
32	*Trichothecium roseum*	1.9	6.7	20.0	–	3.4	13.3
33	*Epicocum nigrum*	3.7	13.3	16.7	–	2.5	10.0
Total quantity isolates, pcs.		108	–	124	–	116	–

Mycelia sterilia (9.2%), *Fusarium sporotrichioides* (9.6%), were the most frequent, while the least frequent were *Alternaria alternata*, *A. tenuissima*, *Fusarium verticillioides*, *Trichothecium roseum* – 1.9%.

Seeds selected from middle-aged plantings were most populated with the spores of *Trichoderma viride* – 95.8%, *Alternaria alternata*, *Mycelia sterilia* – 83.3%, *Cladosporium cladosporioides* – 79.2%, *Fusarium oxysporum*, *F. sporotrichioides* – 66.7%. The lowest population rate was observed for micromycetes of *Absidia glauca* – 3.3%, *Mortierella alpine*, *Penicillium chrysogenum*, *P. cyclopium* – 6.7%. Highest occurrence frequency (seeds selected from middle-aged plantings) – *Mycelia sterilia* – 40.0%, *Trichothecium roseum* – 20.0%, lowest – *Mucor globosus*, *M. hiemalis* – 0.8%, *Penicillium chrysogenum*, *P. cyclopium* – 1.6%, *Absidia glauca* – 4.0%.

Seeds collected from a mature plantation were the most polluted with *Aspergillus niger, Fusarium verticillioides* (37.5%), *Aspergillus terreus (*25.0%), *Mycelia sterilia* (23.3%). The lowest population coefficient is observed in the species of *Penicillium chrysogenum*, *P. cyclopium* (3.3%), *Mucor hiemalis*, *Rhizopus nigricans*, *Cladosporium cladosporioides*, *C. herbarum* – 6.7%.

The maximum occurrence frequency is in *Aspergillus niger* (7.7%), *Penicillium funiculosum*, *P. lanosum* (5.2%), *Mycelia sterilia* (5.0%), minimum frequency – *P. chrysogenum* (0.8%), *Absidia glauca*, *M. hiemalis*, *Rhizopus nigricans*, *Cladosporium cladosporioides*, *C. herbarum*, *Fusarium verticillioides*, *F. sambucinum* – 1.7%.

Dominant among all age groups were the following species: *Trichoderma viride* (20.0-95.8%), *Mycelia sterilia* (33.0-83.3%), *Alternaria alternata* (6.7-83.3%), *Cladosporium cladosporioides* (6.7-69.2%).

The similarity of the species composition of mycobiota seeds selected from young and medium-aged plantings (similarity indicator – 84.2%) and medium-aged and mature ones (similarity indicator – 89.4%) was established. Less similarity was observed between the species composition of fungi identified on seeds selected from young and mature plantings (the similarity rate is 3.6%). The most similar seeds were middle-aged and mature plantings, the least similar – young and mature ones.

Conclusions

As the analysis of the similarity of micromycetes of Scots pine seeds selected in plantings showed,the largest number of micromycetes was identified in seeds from wet (A_3) – 189 species and fresh barrens (A_2) – 103 micromycetes, while the smallest was from the fresh (B_2) – 92 types and wet su-barrens (B_3) – 93 isolates; the largest number of micromycete species was observed on Scots pine seeds selected from middle-aged plantings (124 strains). Seeds selected from young stands of Scots pine have the highest occupancy rate.

The dominant species in all types of forest conditions were *Penicillium cyclopium*, *Alternaria alternata*, *Cladosporium cladosporioides*, *Fusarium sambucinum* micromycetes (75% settlement rate), which are most dangerous for the development of healthy planting material.

Mycobiota of Scots pine seeds collected in fresh su-barren (B_2) and wet su-barren conditions (B_3), were the most similar (1.6%). Mycobiota of seeds from fresh barren (A_2) and wet barren (A_3) in the species composition is similar.

The highest occurrence frequency and the occupation rate on seeds selected from different conditions were observed in *Alternaria alternata* (OF – 7.4-10.0%, OR – 10.0-83.3%); *Cladosporium cladosporioides* (OF – 1.7-12.5%, OR – 53.3-79.2%); *Fusarium oxysporum* (OF – 2.5-6.7%, OR – 46.7-66.7%); *Mycelia sterilia* (OF – 3.0-40.0%, OR – 33.3-83.3%).

It was identified that the largest number of micromycete species is observed on Scots pine seeds selected from middle-aged plantings (124 strains). The highest seed occupancy rate selected from young Scots pine stands is inherent in *Mycelia sterilia* (13.3%), *Epicocum nigrum* (16.7%), *Aspergillus niger (*30.0%), the smallest – *Paecilomyces varioti*, *Penicillium chrysogenum* – 6.7%.

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Вплив умов місцезростання на зміну видового складу мікобіоти насіння сосни звичайної

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Анотація. Досліджено видовий склад мікроміцетів насіння сосни звичайної, зібраного з насаджень, що зростають у різних лісорослинних умовах, та відібраного з дерев різних вікових груп. Встановлено, що на насінні найчастіше траплялися види мікроміцетів – *Alternaria alternata*, *Cladosporium cladosporioides*, *Fusarium oxysporum*, *Mycelia sterilia*. Визначено домінантні види мікроміцетів, зокрема *Penicillium cyclopium*, *Alternaria alternata*, *Cladosporium cladosporioides*, *Fusarium sambucinum*, які найбільш небезпечні для розвитку здорового садивного матеріалу. Ідентифіковано найбільшу кількість мікроміцетів із насіння насаджень, що зростають в умовах вологого (A_3) – 189 видів та свіжого бору (A_2) – 103 мікроміцети, а найменшу – свіжого (B_2) та сирого субору (B_3), відповідно 92 і 93 ізоляти. Найбільшу частоту трапляння на дослідних зразках насіння сосни звичайної, відібраного з насаджень свіжого бору, мали мікроміцети *Penicillium cyclopium*, *Alternaria alternata*, *Trithothecium roseum*, а найменшу – *Mortierella alpine*, *P. canescens*, *P. lanosum*, *P. variabile*, *Fusarium sporotrichioides*. Зазначено, що найчастіше на насінні, яке відібране з дерев різних вікових груп, траплялися *Mycelia sterilia* (9,2 %), *Fusarium sporotrichioides* (9,6 %), тоді як найменшу частоту трапляння мали – *Alternaria alternata*, *A. tenuissima*, *Fusarium verticillioides*, *Trichothecium roseum* – 1,9 %. Досліджено подібність видового складу мікобіоти насіння, відібраного з молодих та середньовікових насаджень (показник подібності – 84,2 %) та середньовікових і стиглих (показник подібності – 89,4 %). Меншу подібність спостерігали між видовим складом грибів, ідентифікованих на насінні, відібраному з молодих та стиглих насаджень (показник подібності становить 73,6 %). Найбільш подібним було насіння середньовікових і стиглих насаджень, найменш подібним – молодняків і стиглих. При цьому насіння, відібране із різних вікових груп, є різним за видовим складом мікроміцетів (подібність варіювала у межах 73,6-89,4 %)

Ключові слова: вікові групи дерев, мікобіота, тип лісорослинних умов, мікроміцети, сосна звичайна