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CHARACTERISTICS OF THE CONDITION AND REPRODUCTIVE PROCESSES OF TREES IN A CLONE PLANTATION OF *PINUS SYLVESTRIS L.* FINNISH ORIGIN IN THE CONDITIONS OF LYTYN FORESTRY OF THE VINNYTSKY REGIONAL FORESTRY

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The article presents the results of long-term studies of the condition and reproductive functions of trees in a clonal plantation of Pinus sylvestris L. of Finnish origin, located within the Lityn Forestry of the Vinnytsia Forestry District. Regular observations were conducted during 2012–2025, using data from previous observation periods (1994–1999, 2010–2011). The main attention was focused on indicators of tree survival, the intensity of formation of reproductive structures (macrostrobili) and the assessment of the general physiological state of different Scots pine genotypes. At the time of registration in 2025, the survival of trees was about 94%. Of the initial number of 413 individuals, only 22 died, which indicates a high viability and stability of the plantation. The greatest loss was recorded in clones E2312 (33.3%), E2257 (20.0%) and K801 (20.0%), while most genotypes, including local populations, are characterized by 100% survival. This indicates the heterogeneity of the adaptive potential of different genotypes and the significant role of hereditary variability in ensuring the stability of the plantation. The results of tree-by-tree records of macrostrobil formation showed significant differences in the level of reproductive activity of clones. During 2010–2025, clones E80, E709, E2209, K818 and the local population were distinguished by a consistently high intensity of cone formation. The average intensity of cone formation ranged from 0.6–2.0 points, and in the most productive genotypes (E80, E709) it exceeded 2.0 points. Low seeding intensity was characterized by clones K684 and K912 (1.1–1.3 points). Depending on weather conditions, individual genotypes showed a tendency to improve reproductive characteristics in the dynamics of the years, which indicates the plasticity of the response to climatic factors.

In 2025, the average level of formation of 1-year-old cones on the plantation was 2.2 points. The highest reproductive activity was recorded in clones E1881, E2125, E80 and local control (2.8–2.9 points). The maximum intensity values (up to 4 points) were observed in clones E2125 and E80. In terms of the formation of 2-year-old cones, the highest indicators were observed for the genotypes E620, E627, E80 and K818, with an average level of 3.0–4.4 points, while the minimum values (1.9 points) were characteristic of the clones E1944 and K294. The genotype E80 was consistently among the most productive for both 1-year-old and 2-year-old cones, which gives grounds to consider it one of the most promising for use in breeding programs.

The physiological condition of the trees on the plantation is generally assessed as good. The average category of tree condition in 2025 was 1.3 points, which corresponds to a satisfactory level. The best condition (1.0 point) was characterized by clones E2209, E2312, E615A, E616D and the local control. At the same time, the deterioration of the condition was observed in clones

E2226,K294, K801 and K919 (1.7–2.8 points). Particularly pronounced weakening was recorded along the perimeter of the site, where the action of abiotic and biotic stressors is more intense. The generalized results indicate that Pinus sylvestris L. of Finnish origin demonstrates high adaptive capacity to the conditions of the Forest-Steppe of Ukraine. Despite local fluctuations in the condition and productivity of individual clones, the plantation generally retains stability and a good level of reproductive processes. The average reproduction score for the two-year cycle is 2.7, which indicates sufficient potential productivity and the possibility of using the studied genotypes as donors in seed breeding programs.

Key words: *Pinus sylvestris L. of Finnish origin, reproduction, condition, clonal seed plantations.*

Table 5. Fig. 1. Ref. 15.

Problem statement. Forest ecosystems play a key role in ensuring the sustainability of the natural environment and are centers of biological and landscape diversity. Intensive use of forest resources over the last century has led to a significant decrease in the share of natural forests, disruption of natural genesis, changes in the species and age structure of forest stands. In this regard, a number of important initiatives have been adopted at the global level to preserve forest biodiversity, and the concept of Balanced Forest Management has been developed and implemented. Forest genetic resources are one of the main criteria for balanced forest management [1].

The strengthening of the negative impact of abiotic and biotic factors leads to the intensification of the processes of drying out and degradation of stands, a decrease in the share of the main forest-forming species in the composition, a decrease in their productivity and ability to natural seed reproduction. In solving the problems of preserving biological and genetic diversity, the issues of adaptation to environmental changes, increasing resilience, productivity and reproductive capacity at the individual and population levels are among the key ones. This necessitates the need for detailed comprehensive studies of the current state of forest genetic resources and the development of measures to improve methods for increasing their resilience and reproductive functions in conditions of environmental change. The article presents an assessment of reproductive processes in clonal plantations of *Pinus sylvestris L.* of Finnish origin, assesses the condition of trees, features of their growth and development [6].

Analysis of recent research and publications. The growth of anthropogenic impact on forest ecosystems increases the vulnerability of forest stands to abiotic (climate change, extreme weather events, pollution) and biotic factors (mass reproduction of pests, spread of diseases). This leads to disruption of physiological processes in tree species, reduces their ability to naturally regenerate and threatens the long-term stability and functioning of forest ecosystems [5].

Scientific studies confirm the important role of *Pinus sylvestris L.* in the formation of forest ecosystems in Northern and Eastern Europe, as well as its key importance for the sustainable development of forestry [8]. Numerous works have examined the features of growth, ecological adaptation, genetic variability and economic use of this species in different natural and climatic zones, which

emphasizes the relevance of further research on *Pinus sylvestris L.* in the context of modern climate change [11].

The range of *Pinus sylvestris L.* covers a wide area from Scandinavia to Central Asia, but it is the Finnish populations that attract special attention of researchers due to their increased frost resistance, tolerance to drought conditions and resistance to temperature fluctuations. Scientific works show that *Pinus sylvestris L.* of Finnish origin demonstrates stable growth rates even in harsh climatic conditions, is characterized by a high level of winter hardiness and a long period of viability [14].

The ecological role of *Pinus sylvestris L.* is also actively studied in scientific publications. Some authors emphasize its importance for maintaining the biodiversity of boreal forests, regulating the water regime and preventing erosion processes [12]. Some works consider its ability to absorb significant amounts of carbon dioxide and influence the microclimate of regions [15]. Regarding economic use, numerous studies confirm that *Pinus sylvestris L.* wood is widely used in the pulp and paper, furniture and construction industries [9].

Pinus sylvestris L. clonal plantations are an important component of modern forest seed production aimed at increasing the productivity of forest stands, improving their genetic characteristics and resistance to climate change and diseases. The issues of creating, forming and using such objects are actively covered in world and domestic literature. Modern studies show that the use of clonal plantations allows significantly accelerating the process of growing stands and increasing their productivity. Modern technologies for creating and growing clonal plantations contribute to obtaining highly productive, selectively improved seed material [6].

In the context of forestry management in Ukraine, the issue of creating and operating clonal plantations of European spruce is becoming relevant. According to research [8], the use of such plantations contributes to increased resistance to abiotic and biotic factors and ensures stable indicators of forest productivity.

Despite significant successes in the use of clonal plantations, there are still a number of open issues related to the reproductive capacity and stability of pine stands, their impact on biodiversity and the economic feasibility of their cultivation. That is why further study of this issue is relevant and necessary for improving forest seed production methods in order to improve forestry practices. The aim of the research was to investigate the reproductive functions and condition of *Pinus sylvestris L.* trees of Finnish origin in clonal plantations in the conditions of Vinnytsia region; to establish the main trends in the change in the formation of reproductive organs and to develop measures to improve the seed productivity of seed plantations.

Materials and research methods. A clonal plantation of *Pinus sylvestris L.* of Finnish origin was created in the spring of 1992 at the State Enterprise «Khmilnytske Forestry», Litynske Forestry in block 35. The total area of the plantation is 2.58 hectares. The category of the plot is agricultural land, arable land. The plot was prepared using the black fallow system after grain crops. Preliminary winter plowing was carried out on the plot in the fall of 1991. In the spring of 1992, simultaneous

harrowing and loosening of the soil to a depth of 26-30 cm. The relief and exposure of the slope are flat, even. The type of growth conditions is fresh oak forest. The predominant soil type is dark gray forest, medium loamy. The plantation is created by grafted *Pinus sylvestris L.* seedlings with a closed root system. The total number of clones of Finnish origin is 30, and 1 is a local control [6].

The analysis of the preservation of clones in the *Pinus sylvestris L.* plantation during 1993-1999 indicated their insignificant loss. Of the 400 ramets presented, only 5 were noted to have withered (clones E2257, E620, E2226, K294). As of 2025, part of the plantation is thickened due to the growth of companion species and shrubs. In the following years, it is advisable to remove companion species in the rows [13].

Fig. 1. General view of the clonal plantation, the condition of the trees and their reproduction (as of October 2025)

Source: based on own research

The study of the condition and reproductive processes in clonal seed plantations of *Pinus sylvestris L.* Finnish origin was conducted in the conditions of the Lityn Forestry Department. When conducting the research, generally accepted methods in forest taxation, forest selection, silviculture, and forest dendrology were used. For each tree, the following were determined: condition according to the Sanitary Rules in the forests of Ukraine; intensity of formation of microstrobili, and formed cones.

In field studies, a 6-point scale was used to assess the condition of trees. Trees of the 1st condition category included healthy trees without any signs of crown damage or drying; leaves (needles) are green, without signs of damage, drying, or color change; high growth energy is maintained in linear and radial growth; condition category 2 – relatively healthy trees with minor signs of damage to the crowns or trunk, trees that are characterized by some decrease in linear and radial growth; trees of the 3rd condition category are characterized by a deteriorated condition [11]. Crowns and trunks of trees with visible signs of damage and drying, growth is significantly reduced, damage or drying of the crowns is about 30-50%; there is suppression of both linear and radial growth; condition category 4 – trees in the stages of drying; the living part of the crown is no more than 30-50% or more; signs of digression and drying are clearly visible; needles fall off, or their yellowing, browning occurs; linear or radial growth is almost absent; condition category 5 – fresh deadwood (trees that died during the growing season, or during the last year); the crown skeleton is not destroyed; the 6th category of condition – old deadwood – trees that died in previous years. The crown is characterized by varying degrees of destruction depending on the age of drying [12].

The intensity of the formation of reproductive organs was determined on a 5-point scale. In particular, complete coverage by reproductive organs – 5 points (100%), somewhat incomplete coverage – 4 points (about 80%), average – 3 points (about 60%), low – 2 points (about 40%), almost absent – 1 point (about 20%), absent – 0 points (0%). According to these characteristics, the intensity of the formation of macrostrobili and formed cones was assessed. For *Pinus sylvestris L.*, the intensity of the formation of 1-year-old and 2-year-old cones was determined. The data obtained were also processed in office conditions. Field data were processed using the Excel statistical software package [11].

Research results and their discussion. Regular records of the condition and reproductive functions of trees in a clonal plantation of *Pinus sylvestris L.* Finnish origin were conducted during 2012-2025. The main attention was paid to the condition and preservation of trees. First of all, a high level of preservation of trees was noted on the site, which currently amounts to about 94%. With an initial number of trees – 413, only 22 died. In general, the loss in terms of genotypes was 1–4 trees. The highest loss was characteristic of clones: E2312 (33.3%), E2257 (20.0%) K801 (20.0%). Most of the genotypes, including offspring of local origin, are characterized by 100% preservation. The rest of the clones are characterized by insignificant loss – within 7–8%.

Regular observations of the formation of reproductive organs on the plantation were carried out from 1994–1996 to 1999 and during 2011–2025. According to the results of the tree-by-tree accounting of the formation of macrostrobils in 2010–2025, a consistently high yield of clones E80, E709, E2209, K818 and the local population was revealed. Some clones with an extremely low level of reproduction in the previous period were characterized by a significant increase in yield in subsequent years (E636C). The average intensity of cone formation in recent years fluctuated

within 0.6–2.0 points. Along with local control, cone formation was more intense in clones E80 and E709 and averaged over 2.0 points (Table 1).

Table 1

The intensity of formation of 1-year-old cones on a clonal plantation of *Pinus sylvestris L.* Finnish origin (Litynsk Forestry, Vinnytsia Forestry) as of October 2025

Genotype	Number of trees	Intensity of formation of 1-year-old cones, score			Standard deviation, σ	Unshifted variance, σ
		average	*max*	*min*		
E1591	10	2.4	3	2	0.5164	0.240
E1881	13	2.8	3	2	0.3755	0.130
E1883	13	1.5	2	1	0.5189	0.249
E1944	11	1.6	2	1	0.5045	0.231
E2125	13	2.9	4	2	0.7596	0.533
E2131	10	2.2	3	2	0.4216	0.160
E2209	13	2.5	3	2	0.5189	0.249
E2226	15	2.7	3	2	0.4880	0.222
E2254	14	2.1	3	1	0.7300	0.495
E2257	13	2.4	3	2	0.5064	0.237
E2312	11	1.8	2	1	0.4045	0.149
E2650	12	2.3	3	2	0.4924	0.222
E4039	13	2.5	3	2	0.5189	0.249
E615A	12	1.6	2	1	0.5149	0.243
E616Д	14	2.7	4	2	0.7263	0.490
E618	10	2.0	3	1	0.8165	0.600
E620	10	2.7	3	2	0.4830	0.210
E627	13	2.4	3	2	0.5064	0.237
E636C	14	1.5	2	1	0.5189	0.250
E709	12	2.6	3	2	0.5149	0.243
E729	10	2.2	3	2	0.4216	0.160
E80	14	2.9	3	2	0.2673	0.066
K294	12	1.4	2	1	0.5149	0.243
K684	11	1.7	2	1	0.4671	0.198
K795	13	1.8	2	1	0.3755	0.130
K801	12	1.6	2	1	0.5149	0.243
K818	13	2.4	3	1	0.6504	0.391
K912	10	1.3	2	1	0.4830	0.210
K917	13	1.4	2	1	0.5064	0.237
K919	13	1.8	2	1	0.3755	0.130
local control	12	2.9	4	2	0.5149	0.243
Overall summary	379	2.2	4	1	0.7198	0.517

Source: based on own research

The clones K 684 and K 912 were distinguished by a low level of seed setting with an average cone formation score of 1.1–1.3. The intensity of seed setting varied depending on weather and climatic conditions and genetic properties of the clones. The condition of the clones has been deteriorating somewhat in recent years. An increase in the average condition category from 1.3 to 1.7 is observed. The best condition, along with the local control, is characterized by clones E80 and E2125 (condition category 1.2). The condition of clones E1591, E2257, K684, K801, K818, K912 is significantly worse. There are trends in the change in the condition of trees in the plantation. The local population is characterized by the best condition, while clones of Finnish origin are characterized by slightly higher values of defoliation and dechromation. According to the results of the tree-by-tree accounting of macrostrobil formation 2010–2022, a consistently high yield of clones E80, E709, E2209,

K 818 and the local population was revealed. Some clones with an extremely low level of reproduction in the previous period were characterized by a significant increase in yield in subsequent years (E636S). The average intensity of cone formation in recent years fluctuated within 0.6–2.0 points. Along with the local control, cone formation was more intense in clones E80 and E709 and on average amounted to over 2.0 points. Clones K684 and K912 were distinguished by a low level of seed setting with an average cone formation score of 1.1–1.3.

The intensity of formation of 1-year-old cones on a clonal plantation of *Pinus sylvestris L.* Finnish origin (Litynsk Forestry, Vinnytsia Forestry) as of October 2025 is shown in Table 2. According to the table, the highest intensity of 1-year cone formation was in clones of Finnish origin: E1881, E2125, E80 and in the local population (local control).

Table 2

Grouping of genotypes by the intensity of 1-year cone formation in a clonal plantation of *Pinus sylvestris L.* Finnish origin (Lityn Forestry, Vinnytsia Forestry) as of October 2025

	Intensity of cone formation in the 1st year, score		
	1.3-1.8 (low)	1.9-2.4 (average)	2.5-3 (high)
Intensity of cone formation in the 1st year by genotypes	K912	E618	E4039
	K294	E2254	E2209
	K917	E729	E709
	E636C	E2131	E616Д
	E1883	E2650	E2226
	E1944	E1591	E620
	E615A	E627	E1881
	K801	E2257	E2125
	K684	K818	E80
	E2312	-	local origin
	K795	-	-
	K919	-	-

Source: based on own research

The average score of 1-year cone formation in these origins was 2.8-2.9 points. The maximum reproduction score for the indicated clones was 3-4 points.

The intensity of formation of 2-year-old cones on a clonal plantation of *Pinus sylvestris L.* Finnish origin (Litynsk Forestry, Vinnytsia Forestry) as of October 2025 is given in Table 3.

Table 3

The intensity of formation of 2-year-old cones on a clonal plantation of *Pinus sylvestris L.* Finnish origin (Litynsk Forestry, Vinnytsia Forestry) as of October 2025

Genotype	Number of trees	Intensity of formation of 2-year-old cones, score			Standard deviation, σ	Unshifted variance, σ
		average	*max*	*min*		
E1591	10	2.3	5	1	1.059	1.010
E1881	13	2.5	3	2	0.519	0.249
E1883	13	2.0	2	2	0.000	0.000
E1944	11	1.9	3	1	0.701	0.446
E2125	13	2.0	2	2	0.000	0.000
E2131	10	2.6	3	2	0.516	0.240
E2209	13	2.8	3	2	0.439	0.178
E2226	15	4.1	5	2	0.961	0.862
E2254	14	2.6	4	1	0.929	0.801
E2257	13	2.7	4	2	0.630	0.367
E2312	11	2.5	3	2	0.522	0.248
E2650	12	2.7	4	2	0.651	0.389
E4039	13	2.8	4	2	0.599	0.331
E615A	12	2.3	3	2	0.492	0.222
E616Д	14	2.7	3	2	0.469	0.204
E618	10	2.6	4	2	0.699	0.440
E620	10	3.0	4	2	0.667	0.400
E627	13	3.2	4	2	0.801	0.592
E636C	14	2.1	3	1	0.616	0.352
E709	12	2.9	4	2	0.669	0.410
E729	10	2.9	3	2	0.316	0.090
E80	14	4.4	5	3	0.646	0.388
K294	12	1.9	2	1	0.289	0.076
K684	11	2.4	3	2	0.505	0.231
K795	13	2.8	3	2	0.376	0.130
K801	12	2.7	3	2	0.492	0.222
K818	13	3.4	5	3	0.650	0.391
K912	10	2.2	3	2	0.422	0.160
K917	13	2.3	3	2	0.480	0.213
K919	13	2.8	4	2	0.599	0.331
local control	12	2.9	4	2	0.515	0.243
Overall summary	379	2.7	5	1	0.813	0.660

Source: based on own research

According to the table, the highest intensity of 2-year cone formation in 2025 was characterized by the Finnish origin: E620, E627, E80 and K818. The reproduction intensity of these genotypes was on average 3.0-4.4 points. The highest intensity of 2-year cone formation was in the Finnish origin clone E80 (the average score was 4.4). Clones E1944 and K294 were significantly lower in productivity, the average intensity of 2-year cone formation in which was 1.9 points.

Table 4

Grouping of genotypes by the intensity of 2-year cone formation in a clonal plantation of *Pinus sylvestris L.* Finnish origin (Litynsk forestry, Vinnytsia forestry) as of October 2025

	Intensity of cone formation in the 1st year, score		
	1.9-2.7 (low)	2.8-3.6 (average)	3.7-4.5 (high)
Intensity of cone formation in the 1st year by genotypes	E1944	K919	E2226
	K294	E2209	E80
	E2125	E4039	-
	E1883	K795	-
	E636C	E709	-
	K912	E729	-
	K917	local control	-
	E1591	E620	-
	E615A	E627	-
	K684	K818	-
	E2312	-	-
	E1881	-	-
	E2131	-	-
	E2254	-	-
	E618	-	-
	E616Д	-	-
	E2650	-	-
	E2257	-	-
	K801	-	-

Source: based on own research

The condition of trees in the clonal plantation of *Pinus sylvestris L.* Finnish origin (Litynsk Forestry, Vinnytsia Forestry) as of October 2025 is given in Table 5.

According to the table, the best condition (average condition category score 1.0) was characterized by clones of Finnish origin E2209, E2312, E615A, E616D and local control. The condition was significantly worse in the offspring of Finnish origin E2226, K294, K801, K919 (average condition category 1.7-2.8). The trees of clone K294 were cut off with a significant deterioration in condition (average condition score – 2.8). In general, in 2025, trends were noted for the deterioration of the condition of clones of Finnish origin. Particularly intense deterioration of the condition of trees was noted along the perimeter of the site, where the impact of negative biotic and abiotic factors is particularly intense.

Table 5

The condition of trees in the clonal plantation of Scots pine of Finnish origin (Litynsk Forestry, Vinnytsia Forestry) as of October 2025

Genotype	Number of trees	Intensity of formation of 2-year-old cones, score			Standard deviation, σ	Unshifted variance, σ
		average	*max*	*min*		
E1591	10	1.2	2	1	0.422	0.160
E1881	13	1.0	1	1	0.000	0.000
E1883	13	1.1	2	1	0.277	0.071
E1944	11	1.6	3	1	0.674	0.413
E2125	13	1.1	2	1	0.277	0.071
E2131	10	1.4	3	1	0.699	0.440
E2209	13	1.0	1	1	0.000	0.000
E2226	15	1.7	3	1	0.617	0.356
E2254	14	1.1	2	1	0.267	0.066
E2257	13	1.6	2	1	0.506	0.237
E2312	11	1.0	1	1	0.000	0.000
E2650	12	1.3	2	1	0.492	0.222
E4039	13	1.5	2	1	0.519	0.249
E615A	12	1.0	1	1	0.000	0.000
E616Д	14	1.0	1	1	0.000	0.000
E618	10	1.3	2	1	0.483	0.210
E620	10	1.4	3	1	0.699	0.440
E627	13	1.5	4	1	0.877	0.710
E636C	14	1.4	2	1	0.497	0.230
E709	12	1.3	2	1	0.452	0.188
E729	10	1.2	2	1	0.422	0.160
E80	14	1.1	2	1	0.363	0.122
K294	12	2.8	4	2	0.622	0.354
K684	11	1.5	2	1	0.522	0.248
K795	13	1.2	2	1	0.376	0.130
K801	12	1.7	3	1	0.651	0.389
K818	13	1.3	2	1	0.480	0.213
K912	10	1.4	3	1	0.699	0.440
K917	13	1.3	2	1	0.480	0.213
K919	13	1.7	3	1	0.630	0.367
local control	12	1.0	1	1	0.000	0.000
Overall summary	379	1.3	4	1	0.575	0.329

Source: based on own research

Conclusions and prospects for further research. The *Pinus sylvestris L.* plantation of Finnish origin is in good condition. During the period of operation of the plantation, a slight loss of trees was noted, which is about 5%. The clones of

Finnish origin E2312 (33.3%), E2257 (20.0%) and K801 (20.0%) were the least resistant to environmental conditions. In 2025, the genotypes of Finnish origin E2226, K294, K801 and K919 were characterized by a satisfactory condition (condition index 1.7-2.8). In most cases, tendencies towards partial drying of parts of the tops and an increase in the level of defoliation were noted. Other genotypes were distinguished by good condition. The average level of tree reproduction on the plantation was 2.7 points (on a 5-point scale). The best reproductive functions in terms of the formation of second-year cones were distinguished by clones of Finnish origin E620, E627, E80 and K818. The highest reproductive function in terms of the formation of 1-year-old cones was characterized by genotypes E1881, E2125, E80. The clone of Finnish origin E80 is one of the best in terms of seed setting.

In general, it should be noted the high resistance of clones of Finnish origin in the conditions of the Vinnytsia region. Finnish offspring were characterized by mostly good condition and a relatively high level of reproduction. This indicates high adaptive resistance and plasticity of *Pinus sylvestris L.* to climatic changes.

Список використаної літератури у транслітерації/ References

1. Morhun V.V. (2001). Henetyka i selektsiia v Ukraini na mezhi tysiacholit [*Genetics and selection in Ukraine at the turn of the millennium*]. Kyiv: Lohos, Vol. 3. [in Ukrainian].

2. Zaiachuk V.Ia. (2004). Dendrolohiia. Pokrytonasinni [*Dendrology. Angiosperms*]. Lviv: Kamula. [in Ukrainian].

3. Mazhula O.S. (2008). Kliuchovi momenty rozvytku lisovoho nasinnytstva v Ukraini [*Key moments in the development of forest seed production in Ukraine*]. *Lisivnytstvo i ahrolisomelioratsiia − Forestry and agroforestry.* № 112. 132–134. [in Ukrainian].

4. Mazhula O.S. (2009). Plantatsiine nasinnytstvo: suchasnyi stan i perspektyvy [*Plantation seed production: current status and prospects*]. *Lisivnytstvo i ahrolisomelioratsiia − Forestry and agroforestry.* № 115. 3–10. [in Ukrainian].

5. Mazhula O.S. (2006). Reproduktyvni kharakterystyky rodynnykh i klonovykh nasinnykh plantatsii sosny zvychainoi [*Reproductive characteristics of related and clonal seed plantations of Pinus sylvestris L.*]. *Lisivnytstvo i ahrolisomelioratsiia − Forestry and agroforestry.* № 109. 152–156. [in Ukrainian].

6. Neiko I.S., Kolchanova O.V., Monarkh V.V, Zlenko O.P. (2018). Prostorovyi analiz reproduktyvnykh protsesiv na klonovii plantatsii sosny zvychainoi finskoho pokhodzhennia [*Spatial analysis of reproductive processes in a clonal plantation of Pinus sylvestris L. Finnish origin*]. *Zbalansovane pryrodokorystuvannia − Balanced resource use*. №7. 28–34. [in Ukrainian].

7. Neiko I.S., Matusiak M.V., Razanov S.F., Razanova A.M. Mudrak H.V. (2025). Reproduktyvni protsesy na klonovykh plantatsiiakh yalyny yevropeiskoi finskoho pokhodzhennia v konteksti staloho lisovoho hospodarstva [*Reproductive processes in clonal plantations of European spruce of Finnish origin in the context of sustainable forestry*]. *Silske hospodarstvo ta lisivnytstvo − Agriculture and forestry*.

№ 1 (36). 132-146. DOI: 10.37128/2707-5826-2025-1-10 [in Ukrainian].

8. Neiko I.S., Smashniuk L.V., Yelisavenko Yu.A. (2013). Otsiniuvannia stanu ta nasinnienoshennia kloniv sosny zvychainoi (Pinus silvestris L.) finskoho pokhodzhennia v umovakh Vinnychchyny [*Collection of scientific and technical works Assessment of the condition and seed-bearing of clones of pine (pinus silvestris, l.) of finnish origin in the conditions of Vinninchia*]. *Naukovyi visnyk NLTU Ukrainy: Zbirnyk naukovo-tekhnichnykh prats − Scientific bulletin of NLTU of Ukraine. Collection of scientific and technical works.* № 23 (18). 37–32.

9. Neiko I.S., Smashniuk L.V., Los S.A., Kolchanova O.V., Yelisavenko Yu.A. (2015). Dynamika formuvannia heneratyvnykh orhaniv duba zvychainoho na klonovii plantatsii v umovakh Vinnychchyny [*Assessment of the condition and seed bearing of Scots pine (Pinus silvestris L.) clones of Finnish origin in the Vinnytsia region*]. *Lisivnycha nauka u konteksti staloho rozvytku:* materialy Mizhnar. nauk.-prakt. konf., 29-30 ver. r. Kharkiv: UkrNDILHA, 160–162. [in Ukrainian].

10. Neiko I.S., Yurkiv Z.M. (2017). Adaptyvna zdatnist ta osoblyvosti utvorennia reproduktyvnykh orhaniv sosny zvychainoi (Pinus sylvestris L.) finskoho pokhodzhennia na klonovii plantatsii v umovakh Vinnychchyny [*Adaptive ability and features of the formation of reproductive organs of Scots pine (Pinus sylvestris L.) of Finnish origin on a clonal plantation in the Vinnytsia region*]. *Visnyk Zhytomyrskoho natsionalnoho ahroekolohichnoho universytetu − Bulletin of the Zhytomyr National Agroecological University.* № 1 (58). Vol. 1. 120–127. [in Ukrainian].

11. Neiko I.S., Yurkiv Z.M., Smashniuk L.V., Bohoslovska M.S., Yelisavenko Yu.A. (2016). Otsiniuvannia vplyvu pohodno-klimatychnykh chynnykiv na stan ta nasinnienoshennia yalyny yevropeiskoi finskoho pokhodzhennia na klonovii plantatsii v umovakh Vinnychchyny [*Assessment of the influence of weather and climatic factors on the condition and seed setting of European spruce of Finnish origin in a clonal plantation in the Vinnytsia region*]. *Naukovyi visnyk NLTU Ukrainy: Zbirnyk naukovo-tekhnichnykh prats − Scientific bulletin of NLTU of Ukraine. Collection of scientific and technical works.* № 26 (5) 140–146. [in Ukrainian].

12. Tkach V.P., Los S.A., Tereshchenko L.I., Torosova L.O., Vysotska N.Iu., Volosianchuk R.T. (2013). Suchasnyi stan ta perspektyvy rozvytku lisovoi selektsii v Ukraini [*Current status and prospects for the development of forest breeding in Ukraine*]. *Lisivnytstvo i ahrolisomelioratsiia − Forestry and agroforestry*. № 123. 3–12. [in Ukrainian].

13. Furdychko O.I., Neiko I.S. (2019). Ekolohichni chynnyky formuvannia nasinnievoi produktyvnosti klonovykh plantatsii duba zvychainoho (Quercus robur L.) v umovakh Pravoberezhnoho Lisostepu Ukrainy [*Ecological factors of seed productivity formation of clonal plantations of common oak (Quercus robur L.) in the conditions of the Right-Bank Forest-Steppe of Ukraine*]. *Ahroekolohichnyi zhurnal − Agroecological journal.* № 1. 6–14. [in Ukrainian].

14. Shlonchak H.A., Shlonchak H.V. (2023). Efektyvnist vykorystannia klonovykh plantatsii sosny zvychainoi dlia potreb lisovidtvorennia [T*he effectiveness*

of using clonal plantations of Scots pine for reforestation needs]. *Lisivnytstvo i ahrolisomelioratsiia − Forestry and agroforestry.* № 115. 65–70. [in Ukrainian].

15. Wu D., Pulkkinen P., Pappinen A., Neyko I., Zhang G., Di Heinonen, Repo T. (2023). Frost hardiness of Finnish plus tree progenies of Scots pine from seed orchards in Finland and Ukraine. *Eur J Forest Res* 142, DOI: https://doi.org/10.1007/s10342-023-01606-4. P. 1467–1477 [in English].

АНОТАЦІЯ

ХАРАКТЕРИСТИКА СТАНУ ТА РЕПРОДУКТИВНИХ ПРОЦЕСІВ ДЕРЕВ НА КЛОНОВІЙ ПЛАНТАЦІЇ СОСНИ ЗВИЧАЙНОЇ (PINUS SYLVESTRIS L.) ФІНСЬКОГО ПОХОДЖЕННЯ В УМОВАХ ЛІТИНСЬКОГО ЛІСНИТВА ВІННИЦЬКОГО НАДЛІСНИЦТВА

У статті наведено результати багаторічних досліджень стану та репродуктивних функцій дерев на клоновій плантації Pinus sylvestris L. *фінського походження, розташованій у межах Літинського лісництва Вінницького надлісництва. Регулярні спостереження проводилися впродовж 2012–2025 рр., із залученням даних попередніх періодів спостережень (1994–1999, 2010–2011). Основна увага зосереджувалася на показниках збереженості дерев, інтенсивності утворення репродуктивних структур (макростробілів) та оцінці загального фізіологічного стану різних генотипів сосни звичайної.*

На момент обліку у 2025 році збереженість дерев становила близько 94%. Із початкової кількості 413 особин загинуло лише 22, що свідчить про високу життєздатність і стабільність насадження. Найбільший відпад зафіксовано у клонів Е2312 (33,3%), Е2257 (20,0%) та К801 (20,0%), тоді як більшість генотипів, включно з місцевими популяціями, характеризуються 100% виживанням. Це вказує на неоднорідність адаптивного потенціалу різних генотипів і значну роль спадкової мінливості у забезпеченні стабільності плантації.

Результати подеревних обліків утворення макростробілів засвідчили значні відмінності у рівні репродуктивної активності клонів. Упродовж 2010–2025 рр. стабільно високою інтенсивністю формування шишок вирізнялися клони Е80, Е709, Е2209, К818 та місцева популяція. Середня інтенсивність утворення шишок коливалася у межах 0,6–2,0 балів, а у найпродуктивніших генотипів (Е80, Е709) перевищувала 2,0 бали. Низькою інтенсивністю насіннєношення характеризувалися клони К684 і К912 (1,1–1,3 бали). Залежно від погодних умов окремі генотипи демонстрували тенденцію до покращення репродуктивних характеристик у динаміці років, що свідчить про пластичність реакції на кліматичні чинники.

У 2025 році середній рівень утворення 1-річних шишок на плантації становив 2,2 бали. Найвищу репродуктивну активність зафіксовано у клонів Е1881, Е2125, Е80 та місцевого контролю (2,8–2,9 бали). Максимальні значення інтенсивності (до 4 балів) спостерігалися у клонів Е2125 та Е80. За формуванням 2-річних шишок найвищими по казниками відзначилися генотипи Е620, Е627, Е80 та К818, із середнім рівнем 3,0–4,4 бали, тоді як мінімальні значення (1,9 бала) були властиві клонові Е1944 та К294. Генотип Е80 стабільно виявлявся серед найпродуктивніших як за 1-річними, так і за 2-річними шишками, що дає підстави вважати його одним із найперспективніших для використання у селекційних програмах.

Фізіологічний стан дерев на плантації загалом оцінюється як добрий. Середня категорія стану дерев у 2025 році становила 1,3 бала, що відповідає задовільному рівню. Найкращим станом (1,0 бала) характеризувалися клони Е2209, Е2312, Е615А, Е616Д і місцевий контроль. Водночас погіршення стану спостерігалося у клонів Е2226, К294, К801

та К919 (1,7–2,8 бала). Особливо виражене ослаблення фіксувалося по периметру ділянки, де дія абіотичних та біотичних стресорів проявляється інтенсивніше.

Узагальнені результати свідчать, що сосна звичайна фінського походження демонструє високу адаптивну здатність до умов Лісостепу України. Незважаючи на локальні коливання у стані та продуктивності окремих клонів, плантація загалом зберігає стійкість і добрий рівень репродуктивних процесів. Середній бал репродукції за дворічний цикл становить 2,7, що свідчить про достатню потенційну продуктивність і можливість використання досліджених генотипів як донорів у селекційно-насіннєвих програмах.

Ключові слова: *сосна звичайна фінського походження, репродукція, стан, клонові насіннєві плантації.*

Табл. 5. Рис. 1. Літ. 15.

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