CONDITIONS FOR THE ESTABLISHMENT OF LODGEPOLE PINE CULTURES IN THE TERRITORY OF THE NORTHEASTERN FOREST-STEPPE OF UKRAINE

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The biosphere, often referred to as the lungs of the Earth, is heavily dependent on forests, which cover approximately one-third of the planet's surface. Forests play a crucial role in converting carbon dioxide into oxygen through the process of synthesis. In addition, forests are a valuable source of timber and other products for the population, and play an important role in water conservation and soil protection.

It is difficult to overestimate the importance of tireless and often unnoticed work for Ukraine, its people and land. Many people don't know that half of Ukraine's forests were created by the purposeful activity of humans, planted, tended and protected by generations of foresters.

The impact of human activity on forestry has undoubtedly been devastating: the destruction caused by wars, revolutions, and man-made disasters has reached unprecedented proportions. However, it is difficult to identify any other area of natural resource management where the positive impact of human intervention is as tangible and significant.

The importance of this is undeniable, as it is not only a quiet refuge for countless people or a valuable resource for the woodworking and food sectors.

The value of forest work to humanity goes beyond the common statement that "forests are the lungs of the planet." There are many other factors that contribute to the exceptional value of forests.

Combating deforestation plays a crucial role in preserving rivers, controlling soil erosion, and preventing droughts and catastrophic natural events.

It is well known that the current challenges we face in Zakarpattia, which lead to significant losses of resources, could have been avoided if more care had been taken to preserve the Carpathian forests more carefully in recent years.

Protecting and expanding our forests, in particular in Donbas, Crimea, Kherson, Mykolaiv and the Carpathians, is not just a desire but a necessity.

Forest plantations are a major factor in maintaining oxygen balance at the global level.

The national economy relies on forests as a valuable source of raw materials, including wood. Wood provides more than 20,000 different materials, including food and other raw materials. Demand for wood has grown significantly along with advances in the chemical industry. The chemical processing of wood raw materials produces many essential products and technical materials, such as pulp, paper, fabric, alcohol, and medicines.

The forests are a valuable source of food, rich in a variety of nuts, mushrooms, and various types of berries: blueberries, cranberries, cranberries, raspberries, and blackberries. In addition, these forested areas provide a range of medicinal resources with a collection of approximately 12,000 types of raw materials. In addition, the forested areas are used for honey harvesting.

The presence of forests plays an important role in the social and recreational aspects of people's lives, contributing significantly to their aesthetic development and leisure.

Due to the growing demand for timber, there is a need to increase the volume of harvesting of forest materials. However, this has led to negative consequences, prompting the search for methods to increase and expand forest areas through artificial tree cultivation. Natural regeneration of forests is a slow process, hence the implementation of artificial reforestation, which involves planting seedlings, saplings, cuttings or sowing seeds to create plantations. This approach not only focuses on reforestation of areas that have been cleared of forests, but also includes reforestation of areas that have never had forests or have been deprived of them for a significant period of time, leading to soil degradation. Afforestation is also carried out in unsuitable agricultural lands to create protective forests and in wetlands. Numerous forest plantations have been created in such areas, so it is extremely important for the entire forestry complex to demonstrate a highly professional and organized capacity, from seed collection to sowing and planting, as well as ongoing care.

HISTORICAL ASPECTS OF INCREASING FOREST PRODUCTIVITY.

In the postwar years, the problem of increasing forest productivity and quality became increasingly important. By the end of the 1950s and early 1960s, various works on this issue appeared. Among them, it is worth noting the fourth edition of "Problems of increasing forest productivity" (1959-1961), as well as monographs by P.V. Voropanov, O.O. Molchanov (1971), V.V. Smirnov (1971), D.F. Sokolov, E.F. Ivanitskaya (1971), N.A. Moiseenko (1972), V.K. Myakushka (1978), V.G. Atrokhin (1980), S.A. Gensiruk (1980), and others. In addition, numerous publications on this topic were presented in scientific journals, for example, by V.V. Protopopov (1970), A.I. Utkin (1970, 1975), A.I. Pitikin (1974), V.S. Shumakov (1975), V.P. Grigoriev, V.K. Hvozdev (1978), V.G. Atrokhin, E.Y. Afonin (1984), and others.

Based on research conducted by S.A. Gensiruk in 1980, it was found that approximately 40% of the plantations in the State Forestry Fund of Ukraine had a specific gravity of 0.6 to 0.5. In addition, the coefficient of utilization of the potential productivity of forest land did not exceed 0.7.

Foresters considered the primary goal to be to increase forest productivity due to the fact that more than a quarter of Ukraine's forested areas are low-density forests, despite some improvements by the end of the second millennium.

The publications of Artemenko, Tyukov, Yarmolskaya (1960), Georgievsky (1960), Melekhov (1962), Loginov (1965) and other respected scientists present a number of exceptional methods for increasing forest productivity. These publications particularly focus on various aspects, such as reforestation of both forest and non-forest lands, revitalization of low-value plantations, and drainage of swampy forests. It should be noted that these measures are tailored to the specifics of Ukraine. M.P. Georgievsky, in particular, proposed a comprehensive set of strategies applicable to forests throughout Ukraine. These strategies included reforestation of non-forested areas, seed production and selection, plantation reconstruction, forest drainage, replacement of mature plantations with seed plantations, use of pre-regeneration, introduction of understory and secondary growth, improvement of soil fertility, timely maintenance felling, and sustainable use of wood, among others.

Melekhov linked productivity measures to deforestation practices. These measures include protecting and caring for young trees during harvesting, as well as initiatives to optimize the use of wood and maximize its potential. In addition, full utilization of harvested trees is emphasized, along with efforts to improve soil conditions through controlled fires and the introduction of special materials. Other strategies mentioned include improving the composition of young plants through lightening and clearing, as well as implementing drainage reclamation projects.

The proposals put forward by B.Y. Logginov primarily concerned Ukraine and covered various problem areas. These included, in particular, a significant improvement in the forest vegetation condition by draining excessively wet lands, protecting forests from diseases and pests, strengthening forest protection from fires, improving artificial reforestation techniques, raising the level of forest management in collective farm forests, implementing a rational approach to the use of the logging fund, and maximizing the use of logging waste.

Back in 1956, academician A. B. Zhukov divided strategies aimed at increasing forest productivity into the following classifications:

Those that increase efficiency by significantly changing environmental conditions.

The goal is to maximize the use of soil fertility by the trees on the territory.

Those that increase the caliber of already established forests and accelerate forest development.

The goal is to eliminate the factors that lead to a decrease in forest productivity. Maximum utilization of the logging stock.

A comprehensive study of the issue of increasing forest productivity was conducted by A.B. Zhukov and A.S. Buzikin, who identified a complex network of interrelated abiotic and biotic factors operating at four different levels: climatic, edaphic, biocenotic, and physiological and biochemical.

Two key factors influence the expansion of forests and the growth of plant biomass in them: the radiation balance of the earth's surface and precipitation. In addition, soil nutrition, as well as the availability of water, heat, and air, play a crucial role in determining the overall health and development of forest ecosystems.

Relationships between and within species in forest ecosystems, known as biotic interactions, play a crucial role in maintaining the balance of trophic relationships. These interactions can be influenced and controlled through a variety of forestry practices, such as logging and fertilizer use.

Vital processes, such as photosynthesis and transpiration, are based on the physiological and biochemical level. In this hierarchical structure, each higher level influences the one below it and at the same time serves as the basis for the level above.

According to Prof. Nesterov, increasing forest productivity requires the introduction of advanced forestry technologies, in particular, focusing on the strategic placement of trees based on specific forest vegetation conditions. In addition, it is crucial to improve these conditions in accordance with the specific requirements of different tree species.

WAYS TO IMPROVE FOREST MANAGEMENT.

Increasing tree productivity depends not only on natural factors but also on the organizational and economic conditions of forestry. Professor Gorshenin recognized this and developed a comprehensive set of measures to optimize productivity. These measures include organizational strategies, interventions aimed at the stand, and measures to improve the condition of forest vegetation.

Activities carried out by the organization: proper use of wood at the stages of supply, transportation and processing of production waste,

reforestation of land unsuitable for agriculture,

protection from pests and diseases, fire prevention, mitigation of damage caused by natural phenomena such as storms and hurricanes, icebreakers, etc. Creating a system of long trails through forests and along waterways. Taking into account the biology of the forest, mechanization of forestry operations is being introduced. The organization of forestry activities is gradually being improved and structured. The main focus is on the development of works that cyclically cover the entire territory of the forestry.

Actions affecting the stand position: selection of appropriate methods of harvesting for main use, taking into account the forest type. practice of preserving soil, undergrowth and trees intact during harvesting. reconfiguration of disturbed low-density and inadequately formed forest formations, selection and cultivation of tree species for seed, selection of species and mixing methods taking into account existing forest vegetation conditions, planting the required number of fast-growing tree seedlings taking into account specific forest vegetation conditions, creation of plots and specialized farms in close proximity to consumers using fast-growing species.

Implementation of a systematic approach to thinning, focusing on maintaining high quality, involving the highest forms and ecotypes in mass selection for many generations, choosing the right methods for cleaning up areas where trees have been cut down, and stimulating natural regrowth, taking into account the specific characteristics of the forest.

Changes affecting the condition of forest vegetation: regulating the water regime of drained forests on both sides, applying mineral fertilizers, controlling runoff and preventing soil erosion;

By creating diverse plantations and carefully managing the density, composition and structure of forest stands, we can effectively maintain and improve soil fertility.

Soil fertility can be improved by adding undergrowth and supplementing the secondary rock layer, if the soil is damaged by fire or mechanical impact;

The process of restoring sandy soils by planting lupine and other legumes.

The priority of artificial reforestation is the uniqueness of natural plantations, which cover most of Ukraine's forests.

Artificial reforestation involves growing trees on carefully prepared soil. Before planting seedlings, the soil is loosened and existing grasses are removed. As the trees mature, selective pruning is done to promote the growth of the main tree species and related varieties, giving preference to those that offer the greatest economic benefit. These strategic actions help to ensure the survival of trees even in difficult environmental conditions and in the presence of various threats.

Artificial plantations, which are all of the same age, have a unique feature. The ability to pre-design and organize the composition of these plantations, along with the possibility of including introductions, greatly simplifies reforestation efforts.

The investment required to create artificial plantations is repaid through significant growth of stem wood within a short period of one to two years, as demonstrated by both medieval and modern plantations.

When it comes to reforestation, both natural and artificial methods have their own unique characteristics. In all types of forested areas, it is important to prioritize the creation of forest crops

The focus of the project is to substantiate the characteristics associated with the establishment of forest crops. These characteristics include different densities, composition and mixing patterns, as well as the way of establishment within a subgroup and subgroup conditions within. In addition, the project aims to study the impact of these characteristics on the productivity of future plantations.

ECONOMIC AND TECHNOLOGICAL STATE OF REFORESTATION.

They are shaped by various environmental factors such as light, heat, humidity, soil properties and biotic interactions. When engaging in artificial reforestation, it is important to consider the growth characteristics of tree species, which can vary depending on the cultivation method and technology used in different environments. These conditions may include unfamiliar practices for the plants, including tillage methods, mixing methods, density, and maintenance. These considerations are important for successful reforestation.

As mentioned earlier, Scots pine is the main species responsible for forest formation in the forestry areas. However, the natural regeneration of this valuable conifer is insufficient due to variations in growing conditions in different climatic zones.

The scientific literature of V.V. Ogievsky (1949) and V.V. Mironov (1977) provides guidance on the creation of pine plantations by sowing or planting methods.

To create sustainable pine plantations in forestry, it is extremely important to understand the various aspects of grafting, pine cultivation, agronomic and silvicultural care. An important role in the successful reproduction of pine plantations is played by the correct choice and application of planting methods.

The conclusions of our study, set out below, to some extent reflect the information gathered from the review of existing literature.

In total, over the past 5 years, the primary enterprise has required 3 thousand kg of seeds for forestry needs. This includes 150 kg of coniferous seeds, 2850 kg of deciduous seeds, 2500 kg of oak seeds and 350 kg of other seeds. To meet this demand, 176.0 hectares of temporary forest-seed plots and 4 permanent forest-seed plots of 45 hectares were allocated for the collection of forest-seed raw materials. In addition, 10 Scots pine trees were officially registered.

The demand for forest seed is largely met by the large number of available forest seed plots and surplus trees in harvest years. However, some seeds are still harvested.

Scots pine cones are processed by the Capera-Gogolitsyn cone dryer located on the company's premises. The cone dryer is adjacent to the seed storage facility, which is used to store seeds.

Growing planting material is a common practice among forestry enterprises. The total area of nurseries is 7.3 hectares. The forestry operates two temporary nurseries with a total area of 0.95 hectares. These nurseries are created specifically on recently cleared areas and remain in operation for 2-3 years. One of these nurseries covers 0.40 hectares and is located in section 23, while the other nursery covers 0.45 hectares and is located in section 60, both with 8 and 14 seedlings respectively.

The main species grown in these temporary nurseries include scots pine, common oak, spruce, black alder and hazel, with an annual production of approximately 100-120 thousand pines and 10-15 thousand spruces.

The cultivation of planting material using agricultural technology is a simple process that involves plowing the soil to a depth of 22-25 cm, followed by manual spring row sowing with row spacing of 30-35 cm. Throughout the growing season, the crop needs regular care, which includes loosening the soil with a hoe about 6-7 times. In this particular method, crop rotation is not implemented, and only peat is used as a fertilizer. Consequently, the harvest mainly consists of class II seedlings, which indicates the need for further improvement of the agricultural technology of growing planting material.

The company's forests are located in the Polissya region, which is dominated by wet and humid subsoil and conglomerates. As noted earlier, the prevailing forest conditions in this area necessitate artificial reforestation. The main reason for this is the insufficient natural regeneration of primary tree species, in particular Scots pine, due to its destruction during mechanized logging. Secondary species, primarily birch, quickly colonize freshly cut areas, which further emphasizes the need to reintroduce the main species. In addition, the remnants of the yellow azalea undergrowth prevent natural regeneration in the logged areas.

In the pre-war era, forestry crops were established in the forestry sector; however, there are no existing records detailing the agricultural methods used to establish them. From the postwar period until the 1960s, small-scale forestry operations were carried out annually, usually covering an area of 10-15 hectares and relying heavily on manual labor. The technology of creating forest crops consisted of preparing narrow strips 0.30.5 m wide with a hoe, located at intervals of 1.5-2 m.

Then, in the spring, annual pine seedlings were planted with the Kolesov sword and hand-cared for for 3-4 years. Initially, the planting density was 11-13 thousand per hectare. In some cases, the crowding of plantations led to the formation of pine monocultures, which is considered a negative phenomenon.

Previously, there were large areas of uncultivated meadows with yellow bindweed undergrowth, which were either overgrown with birch and aspen or remained untouched. But after the consolidation of forestry, timber industry, and chemical forestry enterprises into forestry enterprises, the volume of forestry work increased to 30-45 hectares per year. To eliminate old, cluttered clearings, a mechanized clearing technique was introduced, using a D-210A snagging machine to create 1.5-2 m wide strips every 4-6 m. Mechanized sowing methods were also introduced, using DKLN-6/8 or KLB-1.7 disk cultivators for maintenance. In ten years, all old clearings were successfully restored. From the 1970s to the present, an average of 15-20 hectares of silvicultural work has been carried out annually.

At that time, the process of creating forest crops using agrotechnical methods included mechanized soil cultivation with PKL-70 plows by plowing to a depth of 1012 cm or clearing stumps into defined strips every 3-5 meters. In the first approach, the planting sites were located at intervals of 2.0-3.0 x 0.5-0.75 m with a density of 6.7-4.8 thousand plants per hectare. In the latter approach, planting sites were placed 3-5 x 0.50.7 m with a density of 3-5 thousand plants per hectare.

The main species planted are annual seedlings of Scots pine, Scots oak, northern oak, as well as two-year-old seedlings of hanging birch and black alder.

In freshly cleared areas, predominantly pure pine stands are created, and alder is found in more natural habitats. Over time, birch begins to regenerate, although oak is less common. The introduction of birch into secondary forests is not recommended, as it naturally regenerates well and eventually becomes a strong competitor to pine. If maintenance felling is not carried out in time, birch can overtake pine and become the dominant species. In general, oak regeneration does not threaten pine forests; within 1015 years, oak reaches only half the height of pine. However, the presence of oak in forest plantations has several positive effects, including increased productivity, soil improvement, and increased resistance to disease and fire.

In wet subsoils, oak-pine crops are created using a technology similar to subsoils. In wet soils, black alder cultures are practiced, and in transitional edatopes from wet to wet, oak-alder cultures are created.

In our opinion, the technology of creating forest crops has both positive aspects and disadvantages. On the positive side, we should note the refusal to introduce hanging birch into the crops on clearings, as it successfully regenerates naturally in these conditions. Crop density is mostly environmentally sound. Soil cultivation operations are mechanized, including partial maintenance.

As disadvantages, we should note the relatively poor assortment of species, and the acclimatization of highly productive introductions, such as Japanese larch, is not practiced, as recommended by I.Y. Oliynyk (1990). Furrow tillage is not justified in wet and even damp forest conditions, which leads to waterlogging, slow growth, and even crop death. There is no deep loosening of the soil in the furrows, no return of the chips to the bottom of the furrow, and mechanized planting is rarely practiced. The use of disk cultivators for maintenance in the planting rows leads to cutting of root systems. In relatively poor forest vegetation conditions, it is advisable to apply biological reclamation (sowing perennial lupine), as recommended for these conditions by Melnik (1982).

Both state and district authorities prioritize optimizing forest regeneration and cultivation, as well as improving wood quality. A method of increasing the efficiency of reforestation is the creation of plantations using closed root system (CRS) planting material. This method has been used for about five decades in Europe, the United States, and Canada.

These technologies were developed in countries that have favorable climatic conditions for forest cultivation, with significant precipitation (over 1000 mm per year). However, these methods cannot be universally applied in all natural zones of Ukraine. Another disadvantage is the limited size of containers, block cells and tablets, which makes them unsuitable for use to produce larger quantities of standard planting materials that meet the requirements for tree and shrub seedlings, resulting in the lack of standardized survival rates of planted seedlings provided on the forestry area. Promote scientific and best practices in the production of planting materials of SFAS and use them to create forest crops for various purposes, study the growth and development of forest crops and artificial forests, and develop agricultural technologies, as their planting will help solve and improve methods of forest reproduction Many tasks related to technology. SCA planting material is relevant for use during forest fires and other unfavorable growing conditions.

These recommendations describe the technique of growing planting material in boxes

In accordance with the "Rules for Forest Reproduction", "Instructions for Design, Technical Acceptance, Accounting and Evaluation" and "Rules for Forest Reproduction", the data for the "Recommendations for the use of box -type planting materials with a closed root system for plantations" were developed. "The "Forest Crops by Forest Vegetation Zones" compiled in accordance with the current Forest Law of Ukraine are mandatory for all permanent forest users who plant box-type planting material.

Among the methods of forest reproduction (natural, artificial or combined), artificiality (creation of forest culture) continues to prevail. In the current structure of the forest fund of the left-bank forest-steppe, artificial pine plantations account for approximately 95% of the total area of pine forests. This trend will continue in the future, due to the specifics of pine forestry in the region. Scientists estimate that within 20-40 years, the area of reforestation will tend to increase dramatically as large plantations created in the postwar period, especially within the left-bank forest-steppe, reach maturity.

The upcoming increase in forest restoration efforts will require the vigorous development of the latest technologies for growing planting material that will ensure the efficient creation and cultivation of high-quality forest crops for various purposes.

This will involve the wider use of planting material with the introduction of a closed root system (CRS), which is an important technique in the processes of reforestation and reproduction.

Growing planting material with a closed root system offers numerous advantages that surpass those of an open root system. This method allows for economical application of fertilizers, plant growth regulators and other targeted substances and preparations for each seedling. It also makes it possible to use improved seeds efficiently and to manage the growth of seedlings in a targeted manner, optimizing the ratio of their aboveground and underground parts. Using the CCA method, 2-3 rounds of high-quality planting material can be produced in one growing season, while the planting period for forest crops can be extended throughout the growing season. In addition, large-sized planting material can be used to protect the root system as efficiently as possible, reducing the need for fertilization of forest crops due to the high viability of the planting material. In general, the method of SFM increases the efficiency of forest crop production.

Today, when the climate is becoming increasingly dry, the technology of growing seedlings of WSC deserves special attention. There is no comprehensive study on the impact of different methods of cultivating forest tree species on the overall health and further development of seedlings in the forest environment. As a rule, studies of the effectiveness of planting materials using CSA are limited to the first one or two years after planting in forest regions.

REPRODUCTION OF PINE PLANTATIONS.

To create productive and environmentally sustainable plantations, it is important to make good use of environmental conditions. To achieve this, the complex interplay between environmental factors and the plantation itself must be carefully considered.

In the process of both artificial reforestation and afforestation, it is imperative to take into account the unique growth patterns of the forest community. This involves taking into account various land preparation techniques and technologies, migration patterns, and the ideal density of forest crops in different environmental conditions. Additional considerations include proper care and maintenance of the crops, as well as other important factors.

The growth, development and general condition of forest crops are significantly influenced by a variety of environmental factors. These include, but are not limited to: the quantity and quality of light, temperature, physical and agrochemical characteristics of the soil, the degree of frost and moisture, and the interaction between different biological groups.

In the northeastern forest-steppe of Ukraine, pine is the main tree species for planting, but due to various environmental and economic factors, its natural regeneration capacity is weak or unsatisfactory.

Many scientists have pointed out and convincingly proved that the artificial creation of forest cultures of lodgepole pine should be given priority in reforestation on different areas of forestry.

The main factors in the creation of scots pine forest culture are the choice of the method of its creation, the method of selection and mixing of tree species, taking into account interspecies relationships. It is recognized that planting mixed forests is the

basis for increasing the productivity of plantations.

When selecting varieties of trees and shrubs in mixed plantations, it is necessary to take into account biological and economic aspects, the interaction between which fully corresponds to the conditions of forest vegetation.

There are also scientists who note that the choice of sowing or planting method for creating forest crops is closely related to local growing and climatic conditions. Scientists have concluded that with the help of modern agrotechnical methods, loblolly pine can be successfully grown on fresh, moist clay, sandy and loamy soils with sufficient moisture.

Given the requirements for wood quality, foresters in the late nineteenth century began to focus on planting density. According to V. G. Nestorova, G. F. Morozov and others, intensive culture closes earlier and at lower costs. In addition, with intensive cultivation, the effect of branch cleaning is better, the trunk is flat, and the quality of hardwood is high.

Mr. Georgievsky believes that planting density plays an important role in the cultivation of loblolly pine crops. He draws attention to the fact that low-density plantations provide a greater supply of timber during major felling, but produce low-quality wood. Z. S. Holovyanko argued that the adjacency of closed crops can be reduced by pruning the cuts.

M.M. Padiy noted that the reduction in crown closure affected the number of red pine trunks in which bark beetles live, and the number of stem trees increased. From the monitoring of publications, it can be concluded that most researchers share the views expressed by T.F. Morozov. In fact, the key conclusion is that as the quality of soil for crop growth decreases, it is necessary to increase the initial density of forest crops. This idea is especially relevant for regions such as Polissya and the Forest-Steppe, where the hydrological soil moisture coefficient is equal to or exceeds a certain threshold.

Martynov wrote that reducing the density of pine crops should be treated with great caution, as lodgepole pine plantations in seedlings form clumps, poor clearing of trunks and branches, and poor growth at an early age due to soil erosion.

FEATURES OF CREATING CULTURES OF LODGEPOLE PINE.

An important issue is also determining the optimal density of the main types of crops and subsequent changes in the number of trees to ensure maximum accumulation of plantation biomass. Some scientists believe that well-treated soil, uniform planting sites, the use of high-quality planting material, timely and regular crop care contribute to accelerated plantation growth, and this should be taken into account when developing methods for growing forest crops involving loblolly pine and other species.

Many years of experience in reforestation of Scots pine and other tree species on fresh logs with 1-2 year old seedlings shows that such crops require careful maintenance. Pysarenko pointed out that the resistance of loblolly pine forest crops to natural regenerative shading of herbaceous vegetation and deciduous tree species can be increased by planting large-scale planting material with a height of more than 25 cm.

When reforesting in Polissya, the type of log should be taken into account. When establishing pine plantations on newly harvested pine logs, it is important to give preference to forest crops of Scots pine, which are partially cultivated in mineralized areas and ditches.

The success of reforestation and afforestation largely depends on forestry maintenance, which should be related to the natural and climatic zone, the type of forest vegetation conditions, and the harmfulness of grass vegetation. The negative effects of preparing land for growing forest crops can be remedied by high-quality care.

Practice has proven that the primary requirement of the surface layer preparation structure is to control grass vegetation, among which the roots are the first to absorb water and nutrients, especially cereal weeds.

Gordienko M. I. The biggest competitors of scots pine for moisture and nutrients are other species, in particular, ground marten and creeping heather. Their destruction increases the content of moisture and nutrients - nitrogen, phosphorus and potassium - in the upper soil layer.

AGRICULTURAL TECHNOLOGY FOR CREATING CULTURES OF LODGEPOLE PINE.

When carrying out mechanized care in the third and fourth years, make sure to cut off 51-68% of the damaged root system. In drought conditions, the cut roots cannot recover, as a result of which young loblolly pine trees weaken and slow down in development, even if they recover, their number will decrease by 5 -7 times compared to before the damage.

There is limited information on the use of traditional methods of growth enhancement, coatings that form films of polymers and contain fungicides, insecticides and herbicides, in the cultivation of pine crops. However, the use of the above-mentioned preparations in forestry production allows to protect seeds and roots of seedlings and seedling systems from root rot, to protect the roots of red pine seeds from May rust.

The vigor and efficiency of growth of loblolly pine seedlings in the first years of planting in a permanent place depends on the preparation of the internal seedling. Soil-anchored cultivation of forest crops should be carried out in dry growing conditions in all soil and climatic zones, preferably in fresh cultivation conditions with unstable and insufficient moisture. As an exception, fresh log cabins with a continuous layer of litter can be used to plant Scots pine without soil preparation.

In areas with sparse forests and forest fires, the cost of complete land preparation for forest crops is high. In addition, it is recommended to use natural regeneration of target species in the stands to form future plantations, so in such forests it is recommended to partially prepare the soil for pine crops by conventional felling. The shape of the tape or groove. Many publications by M.I. Gordienko describe the convenience of this method of soil preparation for pine crops.

In the Ukrainian Polissya, most of the territory is covered by sands and poor soils where pine and birch can grow. In the very dry pine conditions of the northern Polissia and forest-steppe regions, the introduction of Banks pine and loblolly pine is recommended, as loblolly pine has high biological resistance in the first decades and grows faster. Banks pine should be introduced into forestry crops in clean rows after one or two rows of loblolly pine.

There are different opinions about the impact of hanging birch on the growth of lodgepole pine, since the roots of lodgepole pine in a mixed forest of pine and birch deviate from the roots of hanging birch, and the mass of pine roots is reduced by 4.5 times. times. The cleaner the stands.

According to Rakhtienko, it is known that the roots of lodgepole pine penetrate deep into the roots of birch, taking advantage of the increased fertility of their rhizosphere. The addition of several hanging birches in the immediate vicinity can also increase photosynthesis in lodgepole pine trees. However, studies conducted on 15-year old lodgepole pine plantations did not reveal any significant differences in tree growth rates in pure plantations compared to those mixed with birch. Mr. Georgievsky noted that birch trees can negatively affect the health and growth of young larch trees.

Compared to the poor forest soil, the subspecies soil is richer and is a sandy loam with a layer of loam and clay deep beyond the reach of its roots.

Therefore, the best mixture for loblolly pine in fresh and moist forest conditions is petiole oak, which increases soil fertility with the onset of autumn and absorbs nitrogen and nitrogen with the same intensity, and less during certain periods of growth. This positive effect on the soil contributes to an increase in the growth rate of scots pine trees, as evidenced by organic precipitation.

When growing loblolly pine, it is better to introduce oak into a clean row every 3 - 5 rows of loblolly pine. During the main harvesting of 9-10-year-old oak pine, the stock of dry oak wood material is 40-50 cubic meters per hectare.

The introduction of the common spruce was proposed by Polystyrol Pogrebnyak, who saw its advantages mainly in its beneficial effect on the subgenus of the common oak. According to Pogrebnyak, the roots of the common oak do not compete with the common spruce, as the oak forms a deep root system, while the spruce has a shallow one [38].

G. F. Morozov noticed that in depleted sandy soil, Scots spruce tends to remain under the cover of the main layer of the plantation. This is because the main layer of the plantation is in much less competition for nutrients. Nevertheless, it is important to note that this phenomenon will inevitably lead to a decrease in the growth rate of Scots pine in the vicinity.

BIOLOGICAL AND ECOLOGICAL FEATURES OF SCOTS PINE.

Ukraine's forest cover is gradually expanding; however, the problem of providing the national economy with timber remains unresolved. To solve this problem, one solution is to grow fast-growing tree species in plantations with a shorter harvesting period. In the northern forest-steppe of Sumy region, this includes Scots pine. In the process of establishing loblolly pine plantations, questions arise about the optimal initial density for crops and the appropriate thinning intensity during thinning operations. Many scientists have tried to solve these issues.

It has been established that the taxation indicators of plantations depend on their initial completeness, which is established during the formation of pine cultures. In addition, it depends on the density that was maintained during thinning of plantations during felling of forest maintenance.

In the late 1970s, researchers conducted a study of loblolly pine plantations that had different initial densities ranging from 1000 to 4000 units per hectare. Their conclusions showed that the ideal density for creating such plantations, according to the data obtained, is approximately 2000 trees per hectare.

According to the research of O.P. Ryabokon on experimental stands of pine of different completeness, it is necessary to carry out timely thinning in densely populated crops (10-20 thousand pieces-ha-1). This is due to the fact that, compared to thinned crops (2.5-5 thousand units ha-1), the average diameter is reduced by 42%, and the volume of trunks - by 106% [10].

Having studied the growth of pine plantations of different densities, Klymenko found that in dense crops, the supply gradually decreases over 50 years. This is in contrast to crops with sparse planting, which show a difference of 27%. The study is documented.

Scots pine *(Pinus sylvestris) is a* tree species that grows in temperate climates and has a wide distribution area. In the Polissia region of Ukraine, Scots pine is the main forest formation type. This tree can grow in both mixed and pure stands, and is common in the northern Forest-Steppe, and occasionally on sandy lands in the Steppe. According to sources, about 35% of the state forest fund of Ukraine is made up of Scots pine.

As a rule, Scots pine grows in the primary forest layer and can reach a height of 20 to 50 meters with a diameter of 1.0-1.5 meters. These measurements differ significantly from other types of forest vegetation. Its crown usually has the shape of a pyramid or cone and ring-shaped branching. When young, the shoots of loblolly pine are greenish, but turn yellow with age. In addition, two conifers 4.5-7 cm long grow on the yellow shoots. The upper shoots are dark green and convex.

Scots pine is not very special when it comes to the fertility of the soil it grows on or the ambient temperature. It can thrive in a variety of trophic and hygrophic conditions, each with a different degree of productivity. Although it prefers sunlight and can tolerate direct exposure, this species does not tolerate shade, especially in the early stages of development. Loblolly pine is also known for its rapid growth rate, with the most significant growth periods occurring between the ages of 20 and 40 years, as documented in the sources.

Despite the difficulties, Scots pine is a tree species that thrives in dry hygrothermal forests and undergrowth due to its xerophytic nature. Loblolly pine is able to adapt to temperature fluctuations and has exceptional frost resistance, which allows it to withstand unfavorable temperature conditions.

The development of the root system of Scots pine depends on the environment in which it grows. As a rule, in areas with moist and fresh soil, a primary root system with accompanying lateral roots is created. Conversely, in dry areas, the root system consists of a weak taproot and strong lateral roots. In areas with excessive moisture, a shallow root system develops instead. The adaptability of the root system to the environment is what makes loblolly pine a valuable tree species that can thrive in a variety of growing conditions, regardless of moisture levels or soil quality. This information is confirmed by sources.

CREATING PINE CULTURES IN FRESH FORESTS.

In the 1800s, the first attempts were made to grow loblolly pine forest crops. Since then, many scientists, including prominent foresters such as Arnold, Shelgunov, Alekseev, and Gordienko, have devoted a significant amount of research to this topic. Their work has been studied and expanded in order to accumulate knowledge in forestry.

In the forested areas of Polissya and Forest-Steppe, where pine plantations grow, boron conditions prevail. These conditions are mainly located in areas that are dry, fresh and moist, but infertile. This is confirmed by sources.

Currently, the main approach to reforestation in newly created forests is to create artificial forest plantations. This approach is justified by the fact that under unfavorable soil and climatic conditions, natural regeneration of loblolly pine is impossible.

Enterprises in Ukraine engaged in intensive forestry tend to favor artificial reforestation over other methods. This is because artificial reforestation offers a number of advantages, including the ability to select specific species for plantations and to plan the number of planting sites on a forestry plot, which leads to faster movement of forest crops into the forest zone. In addition, the costs associated with artificial reforestation are paid off by increasing the timber supply over several years of the existence of the medieval plantations, as evidenced by sources.

When creating forest cultures of loblolly pine in fresh forests, it is recommended to use annual seedlings for planting. The best time for planting is early spring, in dry conditions and on granular soils. In the case of autumn planting, this can also be done on these soils. When creating pine plantations in these conditions, it is advantageous to introduce hanging birch with two-year-old seedlings with strong upper shoulder straps. In addition, the root system should be well developed and branched, with lateral roots.

Seedlings are inspected shortly before planting, and damaged ones are rejected. To prevent the roots from becoming entangled during planting, the root system is cut to a uniform length. Before planting, the roots of the seedlings are dipped in a pot of liquid clay humus, which increases the chances of survival. Additionally, growth stimulants are added to the pot to further promote their survival.

To increase the survival rate and stimulate the growth of loblolly pine seedlings, the introduction of mycorrhizal fungi into the soil has proven to be effective. These fungi are present in large quantities in the topsoil and organic matter found in thriving lodgepole pine habitats.

Scots pine is grown both by hand and with the help of machinery, under the influence of the Kolesov method.

When working with pine environments, it is not recommended to plant loblolly pine seeds. This is due to the correlation between seeds and insufficient soil fertility and moisture content, which are important for seedling growth and maturation.

If there is sufficient moisture, partial sowing is recommended.

In the rich pine environment of Polissia, it is possible to grow both pure and mixed pine plantations. Although pure pine plantations are easier to establish, maintain and develop, they have certain disadvantages. These include lower productivity and biological susceptibility to pests and diseases. On the other hand, mixed plantations have the advantage of being more resistant to such problems.

The impact of pure pine forests on the soil is unidirectional. These plantations accumulate a significant amount of coniferous debris, which is poorly mineralized and leads to soil acidification. As a result, the availability of minerals is limited.

feeding.

The coexistence of deciduous trees with mixed pine plantations has a positive effect on the mineralization of the litter and the accumulation of organic compounds that contribute to soil fertility. Taxation indicators in mixed pine plantations at the age of eight years exceed those of pure ten-year-old plantations. In addition, mixed pine plantations have a higher degree of biological stability, as evidenced by the literature.

Hanging birch and lodgepole pine are often found together in forested areas. However, it is impractical to introduce the common oak into such an environment, as it lacks the necessary nutrition and moisture to survive for more than a year. An exception is red oak, which can be grown in fresh forests as a soil improvement. It is recommended that red oak be no more than one component of a pine plantation. Undergrowth is not typical for pine forests, although rowan and juniper are sometimes found.

There are conflicting opinions among established scientists about the impact of birch on pine growth. A study has shown that if more than thirty percent of birch trees grow next to a pine plantation, it can hinder the growth and progression of lodgepole pine.

According to some scientists, the growth rate of lodgepole pine trees mixed with hanging birch is noticeably slower, and it takes thirty years longer to mature compared to pure crops of the same species.

Until the age of 60, the growth of pine and birch plantations is sufficient to compensate for the losses. However, after the age of 60, the productivity of these plantations is accelerating and exceeding the productivity of pure Scots pine plantations.

When creating new forest areas, experts suggest introducing a variety of forest crops, including:

For fresh felling, a mixture of 75% lodgepole pine and 25% shrubs such as gray alder, juniper and red elder in lowland areas is used. The composition is known as a pine-shrub mix and is achieved by mixing three rows of lodgepole pine followed by one row of shrubs.

The initial composition of pine and birch with shrubs consists of half pine, a quarter of hanging birch and a quarter of shrubs. To mix this composition, plant four rows of scots pine, then one row of shrubs, two rows of hanging birch and another row of shrubs. This type of composition is recommended for use on old farmland and old log cabins. When planting under these conditions, it is recommended to use two-year-old seedlings for hanging birch.

The pine-birch forest type lends itself to a variety of crop combinations, with mixing schemes being viable options in different forestry areas. These mixing schemes have been investigated and documented in the literature.

The density of plantations during their establishment is crucial for the formation of thriving and biologically balanced ecosystems. With increased planting density, movement into the forest is faster and the negative impact of herbaceous vegetation is minimized. In addition, dense plantations experience fewer complications with removing knots during harvesting. However, it should be noted that the maintenance of such crops requires considerable effort, as evidenced by the sources.

To achieve maximum density when planting fresh pine, certain layout schemes are used. These schemes include row spacing of 1.5-2 meters with a planting distance of 0.75-0.5 meters. However, in the case of pine trees, it is important to note that widening the rows may extend the time required for the forested area to be populated by the main species. This information is confirmed by the source.

For optimal reforestation of Scots pine in arid conditions and on grassy lands, it is recommended to carry out continuous tillage as a priority.

The use of continuous tillage contributes to the full mechanization of sowing and crop care. However, this method is more costly and can only be carried out in advance on non-forest lands, wastelands, meadows, clearings, abandoned agricultural lands and forest clearings after uprooting affected by root rot. In such cases, it is recommended to pre-plant hardwoods and shrubs in a mixture. You can also sow perennial lupine in the aisles. To increase fertility, it is necessary to implement a side pairing system with gill treatment elements. To prevent the root fungus from damaging the plantings, it is necessary to destroy the "plow sole" with the RX-60 tools. This will lead to the formation of a taproot system of medieval plantations.

In forests with soaked fresh logs, you can limit yourself to tillage using platforms or strips with the application of PBN-1, PL-1.2 with simultaneous surface loosening.

When constructing new dry log cabins, the process of preparing the soil for forest crops involves the use of loosening equipment. Strip tilling is not recommended in this scenario, as the humus accumulation horizon has limited capacity.

To achieve the best results, it is recommended to use disk harrows (BDNT-2.2, BDT-2.0) to lay strips on the wet ground around the log cabins after removing the stumps. The next step is to cut furrows with the PKL-70 plow and then use the KLB-1.7 cultivator to return the layer to the bottom of the furrow.

In cases where furrow cultivation is impractical, forest crops are grown on platforms. This method of cultivation is commonly used in agricultural regions, as well as during the rehabilitation of low-value plantations and on clearcuts where undergrowth already exists.

In the first years after planting forest crops, agronomic care is of great importance. This care helps to eliminate weeds, which are direct competitors of forest crops, as well as to promote the decomposition of organic residues and generally improve the water and physical properties of the soil.

In early spring and early summer, an excessive amount of weeds may appear, which impede the growth of young loblolly pine trees. The success of their growth and development in the early years depends on the correct implementation of agrotechnical measures.

Frequent application of agronomic practices can damage the root system of Scots pine trees, leading to a discrepancy between the aerial part and the roots. To prevent this from happening in forestry, Polissia recommends 5 -6 agronomic measures, taking into account the condition of the forestry territory and weather conditions. Agronomic care should be carried out within the first three years after planting forest crops. In the first years, a mechanized regime of care is applied using a KLB-1.7 row cultivator, and manual weeding with a shovel in the row. In subsequent years, mechanized cultivation is carried out in the inter-rows with a KLB-1.7 cultivator with an increase in the protective zone to prevent damage to the root system of Scots pine trees.

It is recommended to apply fertilizers in the spring together with agronomic care to enhance the growth of forest vegetation communities.

PROGRAM AND METHODOLOGY OF FIELDWORK.

Materials and methods of the study**. Scots** pine seedlings were grown in 2022 at the selection and seed complex of the State Enterprise "Tomashivske Forestry" from pre-prepared improved seeds: seedlings were grown in open ground using recognized technology, seedlings were placed in boxes for growing in closed ground.

Figure 1. View of the container with seedlings.

Container dimensions: height - 25 cm, diameter - 6 cm, volume - 707 cubic centimeters. The composition of the substrate for filling the container is a mixture of dark gray medium loams and sandy loams with good humus in a 1:1 ratio, transitional peat and humus in a volume ratio of 3:1:0.25. Crops are planted manually: seedlings with ZKS are planted under an electric drill, and seedlings with VKS are planted under the Kolesov sword.

Figure 2.View of seedling plots.

The soil cultivation process involved creating 60 cm wide furrows using a combined forest plow (PCL-70).

In order to study the peculiarities of growing Scots pine in the Romny Forestry, located in the southeastern region of the Left Bank Forest-Steppe, a 0.10 ha experimental plantation was created in 2022-2023. The growth of forest crops obtained from both and seedlings was studied. In the closed environment of individual containers, pine seedlings were grown and in the open ground, various intensification techniques will be used to test their survival and further growth, crop growth, and the possibility of summer planting. Seedlings of SCC and comparison with the growth rates of VCC seedlings.

The location of the planting sites is as follows: seedlings with VCS are placed at intervals of 2.5x0.7 meters, and seedlings with ZCS - 2.5x1.0 meters.

The viability of one- to two-year-old pine seedlings was assessed at the end of the growing season as the ratio of the number of live seedlings to the number of seedlings planted in the experiment, expressed as a percentage. The value M±m represents the mean value of the recorded value together with its standard deviation, expressed as a percentage. This percentage indicates how much the measured value exceeds the control.

Biometric parameters of the pine harvest (average height, diameter and height growth) were determined annually for two years by direct measurements and subsequently recorded in field experiments. At least 150 to 200 seedlings per variant (VCS and WCS) are tested annually.

The visual assessment of the studied crops included an assessment of their hygienic condition. This assessment took into account any observed damage to branches, trunks, roots (both whole and their individual parts), as well as any changes in the shape of the crown. A numerical code [8] was assigned to each type of damage observed. The degree of damage to forest crops was assessed by the condition index (Ic). Ic is calculated according to the following system:

$$Ic = \frac{1}{N}\sum_{j=1}^{N} K_j \cdot n_j \ ,$$

Where: Is is the condition index; Kj is the j-th condition category (from I to VI); nj is the number of pine seedlings of the j-th condition category, pcs.

THE RESULTS OF EXPERIMENT 1.

One of the main advantages of planting material grown in closed ground instead of seedlings grown with an open root system is that it eliminates the need for temporary digging on the territory of the forestry. This approach also minimizes plant injuries during transportation and transplanting into crops. In addition, it makes it possible to extend the period of planting forest crops and applying fertilizers, moisture accumulators and other substances at the required rates for each plant. These advantages were emphasized in the studies of Savich (1979), Zhigunov (2000) and Vedmid (2007).

In the basic nursery of the Hlynske forestry, the survival rate of Scots pine seedlings was assessed, comparing the conditions of open and closed ground. Biometric measurements of the grown seedlings were carried out in the fall. The average biometric parameters, which included the height of the aboveground part, growth and diameter of the root collar, fluctuated in the samples of Scots pine at the end of the growing season.

By analyzing the data, it was confirmed that there is a marked predominance of average biometric measurements in plants grown from seedlings, as opposed to those obtained from VKS seedlings. This statistical analysis was performed to determine the differences between the two groups.

Measurements of biometric and qualitative parameters of the grown seedlings were carried out in the fall. The average values of biometric parameters (height, growth, and diameter at the level of the root collar) of scots pine planting material grown in containers and in closed ground after the growing season differed significantly.

At the end of the initial season of forest crops growth, the results of the research showed that the survival rate of crops grown from WCC seedlings (96%) was significantly higher than that of crops grown from HCC seedlings (80%). Large plant losses (LPL) are associated with damage to the root system by beetles due to possible planting in spring.

As of 2022 (crop age - 1 year), forest crops grown from VCS seedlings were 15 cm high, as opposed to plants with ZCS - 23.9 cm, respectively. In 2023, this figure was 40.6 cm for seedlings with VCS and 50.8 cm for seedlings with ZCS, respectively (Another important biometric indicator is the diameter of the root collar,

which is shown in Table 3.3 - in 2022, it was 6.8 mm in the established cultures of scots pine from seedlings with VCS and 8.5 mm.

The data obtained statistically confirmed the predominance of average biometric parameters of plants in crops created from seedlings compared to crops created from VKS seedlings: 50% higher height, 38% higher growth in height, 25% higher growth and larger diameter of the root collar. This trend is confirmed in forest crops grown from VKS and ZKS seedlings - 78 cm, 15 mm and 33 cm, respectively.

The data obtained statistically confirmed the dominance of average plant biometric parameters in crops created from ZKS seedlings compared to crops created from VKS seedlings: 30% higher height, 17% larger root collar diameter, and 22% higher height growth. It should also be noted that the SCC seedlings produced crops with better storage stability and sanitary conditions - 91 vs. 75%. In general, forest crops grown from SCA seedlings developed successfully due to better survival and growth time of the crop both during the year and within two years.

The comparison found that forest crops grown using closed-root seedlings have a more developed root system at two years of age, including a stronger taproot and lateral roots, compared to crops grown from open-root seedlings. These characteristics generally contribute to improved survival rates and more successful growth for established forest crops. The results of the research are significant and should be taken into account when developing or improving existing regulations for forestry in pine forests.

RESULTS OF EXPERIMENT 2.

The greenhouse soil was sown manually with Scots pine seeds in 2 cm wide strips with a distance of 15 cm between each strip. The optimal biological and economic density for growing annual pine seedlings is considered to be 950-1000 pcs/m^2, which is achieved by sowing 230-260 germinating seeds per linear meter. However, forestry enterprises usually sow 300 germinating seeds per linear meter. This often leads to overcrowding, which results in lower quality seedlings and fewer standard seedlings. To test this, three seeding rates were used simultaneously in the experiment: 200, 250 and 300 seeds per 1 m^2 , or 1.8, 2.4 and 3.0 g, respectively.

Before planting, the greenhouse substrate is prepared. The substrate consisted of alder soil with an acidity level of pH = 5.0. The soil was sifted and laid down with a layer of 30-40 cm, on top of which 5-10 cm of sand was added and dug up by hand. Under the cord, two small ridges 0.8-0.9 m wide with 0.3 m paths were constructed. These ridges were then placed along the greenhouse.

For sowing, we used ordinary first-class pine seeds obtained from the forestry. Before planting, the sowing tapes were applied with Bordeaux liquid at the rate of 0.5 liters per 1 meter. The seeds were planted manually according to the experimental plot layout. The remaining area in the greenhouse corresponded to the standard seeding rate of 3.0 g (300 seeds) per 1 meter. After planting, we installed an irrigation system and started drip irrigation.

During the embryonic stage of ontogenesis, which is related to dry seeds, the main problem is the availability of excess nutrients to support the survival of the embryo until optimal germination conditions are reached. The most favorable conditions for germination are an air temperature of 14-16°C and air and soil humidity of 75-80%. In greenhouse conditions, these factors were regulated, which led to the emergence of healthy sprouts in 10-15 days. It was observed that the density of seed sowing had no effect on seed germination (Table 4).

Table 4. Germination of Scots pine seeds depending on the seeding rate.

Seeding rate, pcs./m	Number of plants, pcs./m	Germination rate, %.
200	184	92
250	235	94
300	273	91

The point at which roots emerge from a seed is the beginning of the germinal stage of ontogeny. In the life of woody plants, the embryonic stage of ontogeny (which covers the period of seed germination and sprouting) is the most important. During the juvenile stage, the development of seedlings can be divided into several phases: emergence of seedlings, formation of true needles, appearance of the apical bud and the beginning of branching. Vegetation observations were conducted, in which the following periods were distinguished: the first period - from sowing to the emergence of mass shoots, the second period - from mass shoots to their complete rooting (in anthers - to the formation of true conifers), and the third period - characterized by intensive growth and formation of shoots.

The seeding rate did not affect the time from sowing seeds to emergence. In all experimental groups, seedlings germinated in 7-8 days. In addition, the formation of conifers after mass germination in all groups took approximately 35-36 days. The simultaneous growth of seedlings with different densities can be explained by their small size during initial development, which allowed them to thrive regardless of the feeding area (Table 2.2).

In the course of further experiments, it was found that a decrease in the feeding area at a higher seeding rate significantly affected the developmental stages of pine plants. At a seeding rate of 200 seeds per meter of furrow, it took 144 days for coniferous plants to form and reach standard seedling sizes. However, with an increase in the seeding rate, the plant nutrition area decreased, and, as a result, this period was reduced. For example, the duration was reduced to 125 days for a seeding rate of 250 seeds per meter and to 105 days for a seeding rate of 300 seeds per meter. The vegetation period for seedlings was also reduced accordingly, namely to 180 days for 200 seeds per meter, 160-250 seeds per meter and 140 days for 300 seeds per meter by the end of the growing season in 2014. Therefore, the denser sowing resulted in faster seedling growth and achievement of the standard height.

Table 5. Development of loblolly pine plants depending on the seed rate.

Seeding rate, pcs./m	Duration of the period, day			
	From sowing to massive shoots	From mass shoots to needle formation	From the formation of needles to the seedlings reaching standard sizes	Growing season, total
200	7	36	144	180
250	7	35	125	160
300	7	35	105	140

The biometric parameters of loblolly pine seedlings, such as their height, root collar diameter and root system length, play a significant role in determining the quality and viability of the planting material during planting. These parameters must meet the standard requirements for optimal results. According to the standard, pine seedlings of the first grade should have a height of at least 15 cm, a root collar thickness of at least 3 mm, and a root system length of at least 20 cm. Pine seedlings of the second grade should have a height of at least 10 cm, a root collar thickness of 2-3 mm and a root system length of 15-20 cm.

The highest values for all biometric parameters, including seedling height, were shown by seedlings grown at a minimum density of 200 pcs/m.

According to Table 3, the diameter of the root neck is 19.2 cm, the length of the root system is 22.5 cm, and the length is 2.8 mm. Seedlings grown at a sowing rate of 250 pcs./m had slightly smaller sizes, but still met the required standards, with a diameter of 16.7 cm and a length of 2.4 mm.

Table 6. Linear performance of loblolly pine seedlings depending on the seeding rate.

Seeding rate, pcs./m	Seedling height, cm	Root neck diameter, mm	Root system length, cm
200	19,2	2,8	22,5
250	16,7	2,4	19,3
300	15,4	1,3	17,2
NIR05	1,1	0,2	1,3

According to Table 3, the measurements for seedlings grown at a seeding rate of 300 per meter gave the lowest biometric parameters with a height of 15.4 cm and 17.2 cm, and a thickness of 1.3 millimeters. The diameter of the root neck did not meet the standard when sowing at maximum capacity. The corresponding length of the seedlings was 19.3 cm.

The optimum density for growing annual pine seedlings in a greenhouse from both a biological and economic point of view is considered to be a density of 950 to 1000 per square meter. During the experiment, 184, 230, and 260 Scots pine seedlings per linear meter were obtained, resulting in 920, 1150, and 1300 seedlings per square meter, respectively (see Table 4). It was observed that the highest number of seedlings was obtained at the maximum density, while the lowest number was obtained at the minimum density. However, not all seedlings reached the required standard size with a root collar diameter of at least 2 mm. Thus, the maximum yield of standard planting material per 1 square meter is achieved at a seeding rate of 250 to 904 seedlings per square meter. At the minimum seeding rate, the yield is somewhat lower - 823 seedlings per square meter, and at the maximum - the lowest - 421 seedlings per square meter.

Table 7. Yield of standard lodgepole pine seedlings depending on the seeding rate.

Seeding rate, pcs./m	Total yield of seedlings, pcs./m^2	The output of the machine	of seedlings
		pcs./m^2	%
200	920	823	89,5
250	1150	904	78,6
300	1300	421	32,4
NIR05	-	29,2	-

The yield of standard seedlings as a percentage of the total number of seedlings is higher than the minimum seeding rate - 89.5%. On the other hand, the average rate gives a slightly lower yield of 78.9%, while the highest rate gives the lowest yield of 32.4%. Optimal yields of standard pine planting material were obtained at seeding rates of 200 and 250 pcs/m. With an increase in the seeding rate, the plant nutrition area decreased, resulting in a shorter growing season for seedlings, which, in turn, allowed them to reach the standard height faster. At the initial stages of development, the seeding rate did not significantly affect the growth rate of plants. Plant density did not affect seed germination, but did affect linear parameters. The minimum density gave the highest values of linear parameters, followed by the average seeding rate, while the maximum seeding rate gave the lowest values.

After conducting research on different seeding rates, it was found that the largest amount of standard planting material was obtained at a seeding rate of 250 seeds per meter. A slight decrease in productivity was observed when the seeding rate was the minimum - 200 pieces per meter, while the lowest yield was recorded when the maximum seeding rate of 300 pieces per meter was used. In addition, the share of standard seedlings in the total number was highest at the minimum seeding rate, lower at the average, and lowest at the maximum.

CONCLUSION.

In the Left-Bank Forest-Steppe of Ukraine, there is a lack of information on the growth characteristics of forest crops, including Scots pine (Pinus sylvestris L.), in different planting environments, such as seedlings with open and closed root systems.

Nowadays, the question of what type of planting material is used in the creation of forest crops is very relevant, since the productivity of future plantations directly depends on it. A study was conducted to compare the growth of scots pine forest crops using seedlings with an open or closed root system over a five-year growing period in the southeastern zone of the Left Bank Forest-Steppe of Ukraine. In the fall of 2022, the experimental crops were planted with annual loblolly pine seedlings that had a closed root system and were grown in open ground conditions. In the spring of 2023, the experimental crops were planted with annual scots pine seedlings that had an open root system and were grown in closed ground conditions.

The creation of facilities that facilitate forest restoration is based on various actions, such as researching areas where deforestation is planned, transferring land for protective plantations, using forest survey data, and utilizing scientific knowledge and successful precedents.

The rules and regulations for the use of forest reproduction technology are established by the SAFR through the development and approval of regulations in accordance with the established procedure. Forest reproduction is carried out with the help of state programs and projects, the priority of which is the use of effective technologies for the creation of highly productive forests consisting of economically valuable trees and shrubs within the established timeframe.

In regions with favorable environmental and soil conditions, the focus is on natural forest regeneration. This approach allows for the creation of highly productive and environmentally sustainable forests in a short period of time while minimizing costs. Permanent forest users and forest owners develop a project for the establishment of forest crops for each plot after a thorough survey conducted at least one year before afforestation. The method of soil cultivation used should provide optimal conditions for the growth and survival of trees. Before planting or sowing, seedlings and seed material can be treated with substances that increase resistance to desiccation, pests and diseases, as well as to increase growth and survival.

To ensure optimal survival and preservation of forest crops, they are planted in certain periods. In the studied range of seeding rates, the highest yield of standard planting material was obtained at a seeding rate of 250 pcs/m. At the minimum rate of 200 pcs./m, the yield is slightly lower, and the lowest is at the maximum seeding rate of 300 pcs./m. At the same time, the yield of standard seedlings as a percentage of the total number is higher at the minimum seeding rate, it is lower at the average rate, and the lowest at the maximum rate.

The planting scheme for seedlings with an open root system is 2.5*0.7 meters, and for seedlings with a closed root system - 2.5*1.0 meters. The study used methods of silviculture, forestry, and forest crops. The data obtained show that the biometric parameters of seedlings, including average height, diameter and height growth, are significantly higher in pine cultures created from seedlings with a closed root system compared to their counterparts grown from an open root system.

When creating pine crops through seedlings with an open root system at the age of two, the growth indicators were as follows: height - 40.6 cm, root collar diameter - 8.6 mm, height growth - 19.5 cm. Instead, the seedlings with a closed root system had a height of 50.8 cm, a root neck diameter of 10.2 mm, and a height increase of 22.2 cm. The difference in relative values between them is 7% in height, 15% in diameter and 4% in height growth.

In addition, it was observed that forest crops grown using closed-root seedlings showed a more advanced root system after two years of growth compared to crops established using open-root seedlings. This advanced system included a strong taproot and lateral roots, which resulted in increased survival and successful growth of the established forest crops. It is important to consider the results of this study when developing or refining existing regulations for forestry in pine forests.

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