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Shyshatska sand arena: History, current state, and prospects of afforestation

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Abstract. Non-afforested lands in Ukraine are the primary instrument for increasing the forest cover of the territory The issue of sand afforestation is relevant in the context of climate change. Treeless sand arenas are a source of dust storms, and deflationary processes that occur lead to negative consequences that are quite difficult to correct in the future. The purpose of this study was to summarise the experience and achievements of the branch "Myrhorod Forest Enterprise" of the State Specialised Commercial Enterprise "Forests of Ukraine" in afforestation of mobile sands in the conditions of the Forest-Steppe of Ukraine. Forest stands are established using one-year-old Scots pine seedlings on sandy soils to achieve the set goal. Testing is conducted using planting material grown under various conditions – in the open ground and in a greenhouse. Extended periods for establishing forest stands beyond agrotechnical terms are examined during the late spring and summer periods using rejuvenated planting material with partially damaged root systems. The current state of plantings within the Shyshatska sand arena is analysed. It is established that in general, the territory of the arena is represented by the entire range of types of forest conditions ranging from bors to mixed broad-leaved forests. The prevailing types of forest-growing conditions are given, among which dry and fresh forests are distinguished. Subors and su-deciduous forests are

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represented on small areas. Deciduous types of conditions are located mainly in the drained areas of the Psel River floodplain. The main forest-forming species on the territory of the arena is Scots pine, which occupies more than 60% of the territory. Also in the lowlands and floodplains of the Psel River stands of Black Alder and Common Oak grow. In the conditions of bors, Scots pine grows in III – Va bonitet class. In richer conditions, subor and su-deciduous forest cultures have better indicators and have a class I-II bonitet, but there are not many of them. The results of this study can be used in the afforestation of sandy lands in the Forest-Steppe of Ukraine and adjacent regions

Keywords: mobile sands; forest sand cultures; afforestation; planting material; Scots pine

Introduction

The importance of forests on a planetary scale is steadily increasing. This is due to the fact that the forest is a powerful factor in the balanced functioning of natural ecosystems, increases their resistance to anthropogenic impact and climate change. At the global level, mutually agreed decisions are being made on forest conservation and reproduction, namely: United Nations Framework Convention on Climate Change (1992), United Nations Convention to Combat Desertification (1994), etc.

The issues of preserving and increasing the area of forests and implementing the principles of sustainable forestry are also acute in Ukraine. One of the main tasks within the framework of the programme of the President of Ukraine Green Country (n.d.), is an increase in the area of forests and bringing the state's forest cover to an optimal level. The programme provides for an increase in the area of forests by 1 million hectares to achieve optimal forest cover. In addition, when creating new forests, it is important not to violate the natural integrity of all components of the ecosystem – flora, fauna, and microorganisms. Therefore, it is advisable to prioritise attention to non-forested areas where the establishment of new forests will have the maximum positive impact on the ecosystem in general. Thus, it is necessary to conduct research on the afforestation of degraded and sandy lands.

According to Yu.A. Bondarenko & I.V. Ivanyuk (2022), existing sand arenas in Forest-Steppe conditions were also forested, but with better results than in the Steppe zone, due to more precipitation and less evaporation of moisture from the soil. Sand arenas which were formed as a result of intense anthropogenic impact were also forested. One of these territories is the Shyshatska sand arena, which is located on the territory of the Myrhorod district of the Poltava region.

Researchers from China, Y. Rong *et al.* (2022) conducted research in the Tengger Desert using various sandstorm management projects. One of the options was to create a "straw chessboard", in the open cells of which various grasses, bushes and trees were planted and sown for the subsequent fixing of the sands. This method helped to partially fix the sand, and straw shields reduced the heating of sand and evaporation of moisture that came with precipitation.

E.A. Elhadi *et al.* (2016) and M. Moradi *et al.* (2017) investigated that the existing organic residues from precipitation after afforestation of sands, artificially introduced organic fertilisers and plant residues (straw shields) in the upper horizons of sandy lands improve the content of the main elements of mineral nutrition in it. There is also a decrease in the pH of the soil from alkaline to neutral. The introduction

of organic waste into desertified sand dune soils has increased the nutrient content and, consequently, the sustainable biological fixation of sand dunes.

Romanian foresters have achieved substantial achievements in reforestation and afforestation. C. Palaghianu & I. Dutca (2017) determined that for the period from 1990 to 2015, the annual volume of reforestation reached the range of 10-15 thousand hectares. Approximately 1% of these territories were occupied by deforested areas with sandy soils. The main species that were planted on sandy lands were Acacia (*Robinia pseudoacacia* L.) and Poplar (*Populus* × *canadensis*).

A study by Z. Vacek *et al.* (2021) in the Czech Republic compared different types of reclamation: areas after coal mining, a former sand pit, and a reclaimed sand dune that was used as pasture. The areas were afforested with Scots pine. (*Pinus sylvestris* L.). Comparing all reclamation options, the highest productivity was determined in the reclaimed coal mine, and the smallest differences between forest and reclaimed areas were documented in the case of a reclaimed sand pit. In terms of climate change, Scots pine has proven to be a very adaptive and suitable tree species, the wood production of which in reclaimed areas after mining is comparable to conventional forest areas. Pine afforestation of reclamation areas brings invaluable environmental and industrial benefits.

Having considered the methods of fixing and afforestation of sands in other regions that were examined by researchers, the purpose of the study was to examine modern approaches and methods of afforestation of sands. The following tasks were considered for this purpose: to examine the survival rate of seedlings in forest plantations depending on their location and agrotechnics of cultivation and analyse the current state of plantations within the Shyshatska sand arena in terms of forest vegetation types, dominant tree species, and stand quality.

Materials and Methods

A work program was developed for the establishment of forest plantations of Scots pine on the Shyshatska Sand Arena by the "Myrhorod Forestry" branch, aimed at investigating the afforestation of mobile sands. The study was conducted from November 2020 to November 2021. According to the work program, the following tasks were envisaged:

- plant seedlings in areas with or without area preparation;
- plant seedlings in extended agrotechnical terms to identify the possibility of extending the planting time (Patent No. 62077. Method for sanitating propagation ..., 2011);
- plant seedlings grown in the open ground, with a closed and partially damaged root system (Maurer & Moiseyets, 2010).
- plant seedlings in spring and autumn agrotechnical terms.

In accordance with the programme of work, experimental crops were created in different agrotechnical terms and using different planting materials (Table 1).

For each research variant, at least 100 Scots pine seedlings were taken. The preparation of seedlings for planting was conducted uniformly to maintain the purity of the experiment. Standard one-year-old Scots pine seedlings of approximately the same size were selected. The root systems were formed to have equal lengths (15-20 cm), and the roots were dipped in a clay-sand slurry without the addition of fertilisers or moisture-retaining agents.

Control was provided by forest plantations created by the employees of the "Myrhorod Forest Enterprise" branch of the State Specialised Enterprise "Forests of Ukraine" within the designated area. Their years of experience in forest

cultivation and restoration within the Shyshatska sand arena demonstrated the utility of adding growth stimulants (rooting compounds, amber acid, and others) and water-retaining agents at 50% concentration as recommended by the manufacturer to the planting mixture.

Table 1. Characteristics of the experiment, in the context of the timing of planting seedlings of Scots pine grown in different conditions

No.	Date of planting	Number of seedlings planted	Origin of planting material
1	09.11.2020	276	Lubenske FE (closed ground, greenhouse)
2	16.11.2020	292	
3	28.03.2021	200	Poltava FE (open ground)
4	11.04.2021	300	
5	23.04.2021	200	Lubenske FE (closed ground, greenhouse)
6	20.05.2021	126	Partially injured root system
7	05.06.2021	108	
8	21.06.2021	111	
9	27.06.2021	108	
10	07.11.2021	103	Poltava FE (open ground)
11	21.11.2021	144	Lubenske FE (open ground)

Note: FE – Forest Enterprise
Source: compiled by the authors

Soil preparation for the study was conducted using mechanised methods. Furrows were created using a PKL-70 plough (Republic of Belarus) at a depth of 10-15 centimetres to prevent the planted seedlings from being buried by sand and avoid any displacement. Adjacent areas were left without soil preparation for comparison purposes. The width of the row spacing was 2 meters, with a step of planting seedlings in a row after 0.5 meters.

The study was conducted on the territory where forest cultures were established on the prepared soil using the PKL-70 plough. Furrows were created to a depth of 10-15 cm to prevent the seedlings from being covered by sands and to avoid lodging. The inter-row width is 2 meters, and the furrow depth during cutting was 20-25 cm, considering the filling by winds and erosion during spring rains (Fig. 1).

Figure 1. Soil preparation using a PKL-70 plough

Standard seedlings of Scots pine were planted with a row planting step of 0.5 meters in different agrotechnical terms in accordance with the research programme (Fig. 2). Planting in May – August was conducted considering precipitation, to maximise the use of moisture by plants.

Figure 2. Planting of annual Scots pine seedlings in experimental plots

The condition of plantations within the mobile sand dune arena was analyzed based on the materials of the periodic forest inventory from the database of the production association Ukrderzhlisproekt (n.d.). For analysis, quadrants within the Shyshatska sand arena were selected within the territories of Shyshatske and Velykobahachanske forest districts of the "Myrhorod Forest Enterprise" branch of the State Specialised Enterprise "Forests of Ukraine".

During the study, the requirements of the Convention on Biological Diversity (1992) were met. The historical aspects of afforestation of shifting sands were analysed based on literary and scientific publications, including the information provided in forestry culture books and the experience of enterprise employees documented in reports and forestry management materials.

Results and Discussion

Sand afforestation has been and remains important since the 18th century. The main focus of the researchers V.N. Vynogradov & D.P. Toropogritsky (1963) was devoted to the afforestation of the Prydniprovsk and Lower Dnieper sands in the southern part of Ukraine. The Steppe zone of Ukraine for almost two centuries was an experimental site of afforestation (Kherson region) and reforestation (Luhansk, Kharkiv region) (Dryuchenko, 1964; Vynogradov, 1966) on sands that man in a very short time turned from blackened sandy steppes and woodlands into bare mobile sands with hilly terrain. The first century of creating sand forests was marked by failures and disappointments, which enriched the Ukrainian forestry industry with invaluable experience, which allowed finding several reliable sand afforestation technologies and applying them in practice. Historical aspects and experience of sand afforestation are given in the studies of M.I. Gordienko & V.P. Shlapak (1998), S.V. Zibtsev *et. al.* (2022).

The most well-known in Ukraine are the Lower Dnieper (Oleshkivske) sands and the sands formed on the land areas located between Kharkiv and Luhansk (Moroz & Shlapak, 2000). Samara forests are located on the sands of

Dnipropetrovsk region. Less known are the island forests that grow on both banks of the Dnipro River, from Kaniv to Zolotonosha and Chyhyryn, where the most famous ones are located – Cherkasy and Chyhyryn forests. (Lehmkuhl *et al.*, 2021).

The total area of the Shyshatska sand arena is 3.1 thousand hectares. Previously, the Shyshatska sand arena was used as a military training ground for throwing aerial bombs, where explosions increased the flowability and mobility of sand. The sand dunes reached heights of up to 10-15 meters, and the depth of sand deposition reached up to 30 meters. Work on the afforestation of mobile sands, which were formed on the site of the military aviation training ground, began in 1952. However, they were unsuccessful; all technologies and scientific recommendations were unsuitable for the conditions of the arena. The temperature of the sand could reach up to +60°C, and in some cases, one-year-old seedlings with a height of 4-5 cm were simply buried during dust storms.

Researchers investigated the prevention of wind erosion by creating mechanical protection using pine branches cut during maintenance operations in young stands to control mobile sand and prevent dust storms in the Shyshatska sand arena (Dryuchenko *et al.*, 1975). Protective rows were arranged every 6 meters perpendicular to the prevailing winds. Although this method gave short-term results since the branches quickly dried up and did not perform their functions. For partial consolidation of the sands, forest cultivation work was continued. Pine seedlings were planted in strips of 3-4 rows. The distance between the lanes was 30-40 m. After the reduction of sand deflation due to the influence of the pine seedlings, large-scale afforestation of the arena began (Bondarenko & Ivanyuk, 2021).

Since 1957, decisive attempts to afforestation the arena have yielded the first results. The plantations were established using a planting scheme with planting spots arranged at intervals of 1.5 by 0.5 meters. Each of the approximately 3 million seedlings was planted manually under the guidance of the "Kolesov's sword" technique over a span of 20 years. Protective structures were placed approximately every 6-7 meters, using shields made from hazel, alder, and pine branches. These shields helped restrain the main force of the sand during storms and protected the pine trees from being buried or having their root systems exposed. Shields were placed at an angle to the prevailing winds and covered the sand arena in a north-south direction. At the end of the growing season, the survival rate of created crops was 95%. Care for crops consisted in uncovering seedlings buried with sand. The full afforestation of the arena was completed in 1975 (Yaresko, 2019). Most of the forest planted in the 1970s was destroyed by a large-scale fire in 2005. Then the fire destroyed more than 450 hectares of forest due to human negligence. The technology that helped reforest the inhospitable desert played against foresters. Due to the fact that the crops were planted thickly, the fire spread very quickly (Yaresko, 2019).

According to Myrhorod Forestry (n.d.), during the reforestation of 2007, the planting scheme was changed – 2.0 × 0.7 m. Scots pine, Crimean pine and Acacia were planted. Soil cultivation mainly involved partial furrowing. On flat areas, planting was carried out mechanically using planting machines, while sandy hills were afforested manually. The primary soil cultivation was carried out through deep loosening using mounted cultivators RN-60 and RN-80 (RN stands for mounted loosener), which facilitated deeper root penetration. Then the addition of cultures was conducted for another 5 years. A general view of the wooded arena after the 2005 fire is shown in Figure 3. Due to the fact that the stumps remained after the fire, it was no longer necessary to put up protective structures. Wide fire breaks were created to protect against fires.

Figure 3. The reforested Shyshatska Arena after the 2005 fire
Source: photo by Google maps (2009)

The created Acacia stands, which served as fire barriers at the age of 12-15 years, started to deteriorate, negatively impacting the condition of the stands.

As of 2023, reforestation efforts are still ongoing in the Shyshatska sand arena. There are isolated cases of death of certain areas of forest cultures due to damage by stem pests and partial covering with sand, despite the fact that preventive measures to combat them are conducted regularly. Currently, with almost 50 years of experience in the afforestation of sands, hygrotopes of afforded areas and fire prevention measures are considered. When creating forest cultures, the width of row spacing is from 2.0 to 2.5 m, the planting step in a row is from 0.5 to 0.7 m, which allows to effectively fixing the sands in conditions from AA_0 to A_2.

Afforestation of the territory of the Shyshatska sand arena is conducted annually. This, in turn, is associated with the partial death of forest crops in small areas. Territories that were covered by a fire in 2005. Depending on weather conditions, such as temperature and sufficient rainfall, they substantially influence the survival and preservation of the established forest cultures. The results of the inventory of forest crops on 15.10.2021 and 25.05.2022 at the experimental sites are shown in Table 2. No additions were made at the experimental sites.

Table 2. Survival rate and preservation of crops in experimental plots

No.	Date of planting	Number of seedlings	15.10.2021	25.05.2022		
			Surviving seedlings, pcs	Survival rate, %	Surviving seedlings, pcs	Survival rate, %
1	09.11.2020	276	105	38	104	38
2	16.11.2020	292	110	38	108	37
3	28.03.2021	200	58	29	58	29
4	11.04.2021	300	81	27	80	27
5	23.04.2021	200	25	13	25	13
6	20.05.2021	126	0	0	-	-
7	05.06.2021	108	10	9	9	8

Table 2, Continued

No.	Date of planting	Number of seedlings	15.10.2021	25.05.2022		
			Surviving seedlings, pcs	Survival rate, %	Surviving seedlings, pcs	Survival rate, %
8	21.06.2021	111	0	0	-	-
9	27.06.2021	108	20	20	19	20
10	07.11.2021	103	-	-	84	82
11	21.11.2021	144	-	-	121	84

Source: compiled by the authors

According to the results of the inventory, it is clear that the terms of planting outside the agrotechnical terms starting from the second half of May do not give positive results. Cultures created in the autumn and spring period have a better survival rate, although it is not enough to leave plots without supplements. Although the sufficient amount of moisture in the spring period, survival rates are low. Sands do not retain moisture in the upper layer, which causes low preservation of created crops.

The results of the autumn planting experiment outside of agrotechnical terms under favourable weather conditions showed excellent results due to the substantial amount of precipitation that was in the region in the winter-spring period of 2022. According to the research programme, planting seedlings on a forest-cultivated area without soil preparation did not give a positive result even using growth stimulators and moisture accumulators. This is due to the formation of a dense upper layer of sand formed by deflation processes, and the burying and damaging of the plantings by sand.

It has been determined that the territory of the arena encompasses the full range of forest vegetation types, ranging from bors to deciduous forests (Fig. 4). This is due to the location of Psel River, which surrounds the sand arena from Southeast to Northeast. The main types of forest-growing conditions are dry and fresh bors, which occupy 60% of the area. Transitional types of subors and su-deciduous forests cover an area of less than 10%. This is due to a sharp transition to deciduous forests in the floodplain of the Psel River. Here, rich conditions were formed as a result of lowering the groundwater level and drying up wetlands (12%). A substantial part of deciduous forest conditions $D_{4\text{-}5}$ (17%) is located in the floodplain of the river and is partially swampy.

The species composition of plantings (Fig. 5) is represented mainly by Scots pine on the sands. Monocultural plantings pose a certain threat during the fire hazard period and require timely logging and maintenance. Common Oak and Black Alder grow in floodplains and partially swampy areas. Other woody species such as Common Ash, Aspen, White Poplar, and Hanging Birch occupy small areas in the transitional subor and su-deciduous types.

Due to the fact that Scots pine is the main forest-forming species of the Shyshatska sand arena, it occupies 63% of the territory and grows on 94% of the sand. The distribution of Scots pine stands by bonitets was analysed (Fig. 6).

After analysing the data shown in Figure 6, it can be argued that in the conditions of dry and fresh bors, pine grows mainly in $2\text{-}5^{a}$ bonitets. Such low bonitets of plantings are fully explained by poor types of forest conditions on the sands, the horizon of which in most areas of the arena is 5-15 m, and sometimes up to 30 meters, and almost no layer of fall-off and litter. A small part of the high-granite plantings was formed along the perimeter of the Shyshatska arena on soils with a less powerful layer of sand up to 1.5 m.

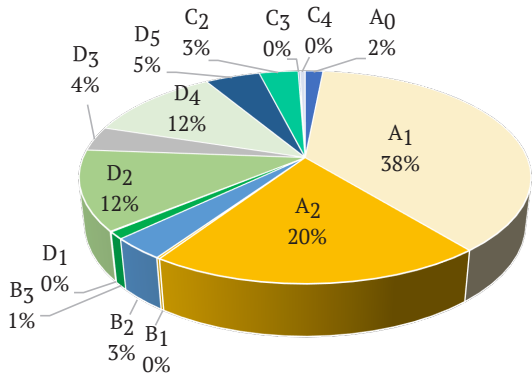

Figure 4. Distribution of areas by type of forest conditions
Source: developed by the authors on the basis of data from the Official website of the Ukrainian State Project Forest Management Industrial Association "Ukrderzhlisproekt" (n.d.)

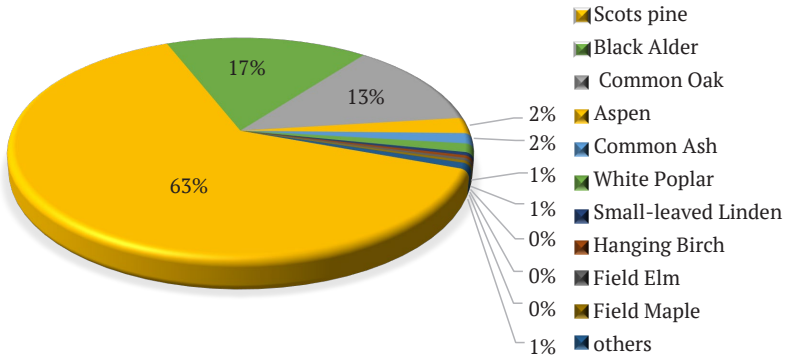

Figure 5. Distribution of areas by forest-forming species
Source: developed by the authors on the basis of data from the Official website of the Ukrainian State Project Forest Management Industrial Association "Ukrderzhlisproekt" (n.d.)

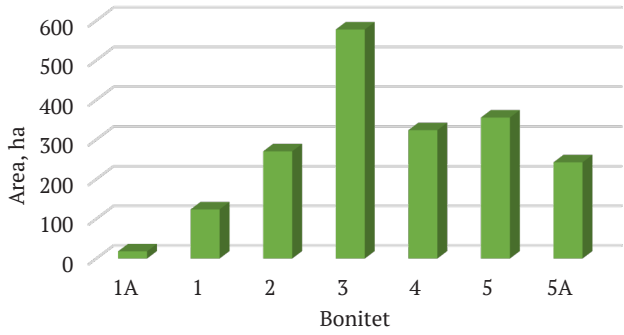

Figure 6. Distribution of the area of Scots pine stands by bonitet
Source: developed by the authors on the basis of data from the Official website of the Ukrainian State Project Forest Management Industrial Association "Ukrderzhlisproekt" (n.d.)

The main goal of sand afforestation in different parts of the world is to improve the ecological situation and reduce dust storms. Ukraine is no exception, and sand afforestation in the south and east of the country is a priority. Atypical plots of land like the Shyshatska sand arena are also found in other regions of the state. In some years, these issues were considered by many researchers and certain results were achieved, on the basis of which this study was based. Thus, the study by M.M. Dryuchenko *et al.* (1975) on afforestation of the sands of the Shyshatska arena with the use and introduction of organic matter in the seating areas was positive. Similar results were recorded by E.A. Elhadi *et al.* (2016) by adding organic residues to sandy soil, it improved its chemical properties and maintained the fixation of sand dunes.

Sand fixing using herbaceous plants in Iran (Moradi *et al.,* 1917) and straw shields in China (Rong *et al.,* 2022) indicates the possibility of partial sand fixation and short-term prevention of deflationary processes. These options are relatively effective and require further afforestation to successfully anchor the sands.

Studies of sandy lands in Europe and their mapping were examined by F. Lehmkuhl *et al.* (2021). The distribution and formation of sands in Europe, considering geomorphological processes, have been examined in detail and provide the opportunity to comprehend the extent of territories that require afforestation. According to Z. Vacek *et al.* (2021), for afforestation of Reclamation lands in the Czech Republic, the best woody species is Scots pine. It is second only by 9-32% in productivity compared to the same plantings on forest soils.

The solution of afforestation of sands on the territory of Ukraine on the lower Dnieper Sands was considered in the papers of V.N. Vynogradov (1963), V.N. Vynogradov (1966), afforestation in the steppe in different years was examined by T.T. Govorova (1970), M.I. Gordienko *et al.* (2002), Prydniprovsk sand formations – P.I. Moroz & V.P. Shlapak (2000). All of them chose Scots pine when selecting tree species for the afforestation of sands. It has one of the largest distribution areas in Europe and a flexible adaptive property to various growing conditions. Considering the different climatic zones of sandy land placement, researchers recommended planting seedlings during periods with maximum accumulation of moisture in the sands, which contributes to better survival and preservation of forest cultures.

The use of different planting dates with improved planting material in Polesia conditions on sod-podzolic sandy loam soils was tested by V.M. Maurer & P.Ya. Moiseyets (2010). Healthy Scots pine seedlings planted in the summer had better preservation in the range of 20-30% compared to similar planting material grown in a nursery in the open ground.

Due to climate changes and possible forecasts of changes in the range boundaries of the main forest-forming species of the Forest-Steppe of Ukraine, Scots pine and Common Oak may shift to the North and Northwest, according to A. Shvidenko *et al.* (2017). Therefore, according to the authors, afforestation of all possible sandy lands is an urgent issue to prevent and mitigate potential negative and unforeseen consequences in the future.

According to the results of this study, for afforestation of sand arenas, it is worth recommending the use of branches from care logging and the formation of a protective fence with a height of 60-80 cm, every 6 meters, perpendicular to the direction of prevailing winds

Considering the prospects of afforestation and stabilizing the shifting sands of the Shyshatska Arena, the "Myrhorod Forest Enterprise" branch possesses substantial expertise. Scots pine stands will form a sufficient layer of litter with time and in the future, the quality indicators will increase proportionally.

Conclusions

Studies have established that the survival rate and safety of forest crops primarily depends on high-quality tillage and moisture reserves after the winter period. The best way to prepare the soil on sand is to cut furrows with a PKL-70 plough using an RN-60 or RN-80 soil loosener. Preparation should be conducted in the autumn period, for maximum accumulation of moisture in the soil.

Planting seedlings outside the agrotechnical deadlines did not give positive results, although the planting of seedlings occurred after precipitation. The best results of seedling preservation were obtained in crops planted in the late autumn period. By that time, a sufficient amount of moisture accumulates in sandy lands, which contributes to better survival. However, it is worth remembering that late plantings can suffer from squeezing seedlings out of the soil by frosts. Due to the fact that the predominant types of forest conditions on the territory of the arena are dry and fresh bors – 58% of the area, pure Pine cultures were formed on sandy soils, mainly of the II-V bonitet classes.

Richer types of forest conditions were formed along the floodplains of the Psel River. Alder trees grow here, which periodically experience short-term flooding during spring floods. A small portion of Common Oak (13%) has developed in drained swamps and wetlands, as well as in low-lying areas and depressions of the sandy arena. Additionally, stands of Aspen have formed in the lowlands of the sandy arena, mostly confined within their boundaries.

Afforestation of mobile sands is necessary in the context of climate change and considers the possible challenges of the present time and the possible negative consequences that have been prevented. Further research on afforestation in the Shyshatska arena encourages a more detailed examination of the structure and composition of the sands. Of particular interest are the features of growth and formation of root systems in the first years. Investigating the growth rate of Scots pine stands on the sands and comparing the results with similar plantings in the region is promising for subsequent research.

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None.

Conflict of Interest

The authors declare no conflict of interest.

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Шишацька піщана арена: історія, сучасний стан та перспективи заліснення

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Анотація. Незаліснені землі в України є основним інструментом підвищення лісистості території. Питання заліснення пісків є актуальним в умовах змін клімату. Безлісі піщані арени є джерелом пилових бур, та дефляційні процеси які відбуваються призводять до негативних наслідків які в подальшому виправити досить складно. Метою даної роботи було узагальнити досвід та напрацювання філії «Миргородське лісове господарство» Державного спеціалізованого господарського підприємства «Ліси України» у залісненні рухомих пісків в умовах Лісостепу України. Для досягнення поставленої мети були створені лісові культури однорічними сіянцями сосни звичайної на пісках. Проведено апробацію із використанням садивного матеріалу вирощеного за різних умов – у відкритому ґрунті та теплиці. Досліджено розширені терміни створення лісових культур поза межами агротехнічних термінів у пізньо-весняний та літній період з використанням оздоровленого садивного матеріалу з частково травмованою кореневою системою. Проаналізовано сучасний стан насаджень в межах Шишацької піщаної арени. Встановлено, що загалом територія арени представлена всією амплітудою типів лісорослинних умов від борів до дібров. Наведено переважаючі типи лісорослинних умов, серед яких виділені сухі та свіжі бори. Субори та судіброви представлені на незначних площах. Дібровні типи умов розміщені переважно на осушених територіях заплави річки Псел. Основним лісоутворюючим видом на території арени є сосна звичайна, яка займає понад 60 % території. Також у низинах і заплавах річки Псел зростають насадження вільхи чорної та дуба звичайного. В умовах борів сосна звичайна зростає за III – Va класом бонітету. У багатших умовах суборів та судібров культури мають кращі показники і мають I – II клас бонітету але їх не багато. Результати даної роботи можуть бути використані при залісненні піщаних земель в умовах лісостепу України та суміжних регіонів

Ключові слова: рухомі піски; лісові культури; лісорозведення; садивний матеріал; сосна звичайна