



INTRODUCTION AND BIOECOLOGICAL CHARACTERISTICS OF CONIFEROUS TREE SPECIES IN THE TURKESTAN RANGE

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Abstract

The article presents the results of studies on the growth and development of six introduced coniferous tree species of the family Pinaceae in the Turkestan Range. All coniferous trees in the Kulsay area were planted at a spacing of 3×2 m over an area of 4 ha, including Scots pine – 0.24 ha, Crimean pine – 0.54 ha, Norway spruce – 0.42 ha, Schrenk spruce – 1.26 ha, Siberian fir – 0.12 ha, and Siberian larch – 1.42 ha. Tree height was 18.6 ± 0.26 m in Scots pine and 17.8 ± 0.24 m in Crimean pine. Norway spruce reached 18.6 ± 0.23 m, Schrenk spruce – 18.2 ± 0.24 m, Siberian fir – 18.8 ± 0.3 m, and Siberian larch – 16.6 ± 0.24 m. It was noted that the growth and development parameters of the coniferous species under the conditions of the Turkestan Mountain Range were lower than those in their natural distribution areas.

Keywords: Pine, spruce, larch, fir, increment, vegetation, introduction, phenological studies, planting scheme, pollination, phenological phases

Introduction

Forests cover one-third of the Earth's land area, or 38 million km², of which 264 million ha, or 7%, are artificial forests. The growing need for the extensive use of coniferous tree species in afforestation and landscaping is one of the pressing



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objectives of scientific research aimed at their introduction into different climatic and soil conditions, as well as at studying their bioecological characteristics under introduction conditions. Among the tree species forming coniferous forests throughout the world, conifers are considered leading species,

Coniferous forests (taiga) occupy vast areas in the northern parts of Eurasia and North America (Canada, the United States, Russia, and Scandinavia). They account for about 50% of the world's coniferous forest resources. The main species include spruce, pine, fir, and larch, forming a continuous belt below the tundra and also occurring in mountainous regions. The main taiga zone extends across Russia (from Karelia to Kamchatka), Canada, and Scandinavia. Coniferous forests occur in the mountains of Europe (the Alps and the Carpathians), Asia (the Himalayas and the Yunnan Plateau), and America (the Rocky Mountains).

Pine forests are widespread in Spain, the Balkans, Asia Minor, and the Canary Islands. Coniferous species are less common in the tropics, occurring mainly in the mountainous regions of Southeast Asia and the West Indies (Caribbean pine). In recent decades, a decline in primary coniferous forests has been observed due to economic activities, diseases, and fires.

It has been established that coniferous forests are widespread in the mountains of Turkey and consist of such coniferous species as Calabrian pine, black pine, Scots pine, Crimean pine, Caucasian pine, white pine, Trojan pine, Lebanon cedar, juniper, and evergreen cypress; in China, Canada, and the United States – pine, Keteleeria, black pine, eastern white pine, hemlock; in Mongolia – larch forests; and in Chile and Argentina – cypress-araucaria forests. In the mountains of Central Asia, the main forest-forming species are junipers: Zeravshan juniper, hemispherical juniper, Turkestan juniper, and Cossack juniper. Representatives of the family Pinaceae include Schrenk spruce (*Picea schrenkiana*) and the endemic Semenov fir (*Abies semenovii*), which occurs only in the mountainous parts of Kyrgyzstan and Kazakhstan. In Uzbekistan, Tajikistan, and Turkmenistan, these species have been introduced and are used for landscaping and afforestation under mountain conditions. Therefore, one of the current priorities is to conduct introduction studies and investigate the bioecological characteristics of



representatives of the family Pinaceae under introduction conditions in order to expand their species composition under arid conditions (Berdiev E.T., Khayriddinov Kh.R., 2025).

The Development Strategy of the Republic of Uzbekistan for 2022–2026 identifies the tasks of “Environmental and ecological protection, improvement of the ecological situation in cities, and implementation of the national project ‘Green Space’.” In this regard, research aimed at expanding the range of coniferous species is highly relevant in order to increase the level of landscaping in various territories, effectively use fast-growing, highly ornamental tree species suitable for arid regions, and reduce the negative effects of environmental factors.

Materials and Methods. The studies were conducted under field and laboratory conditions, as well as using route-based observations. The condition and biomorphological parameters of the stands were determined according to the method of G.N. Zaitseva [1973]; phenological phases were studied according to the method of I.N. Beydeman [1960]; tree productivity was determined using a 5-point scale; seed germination was assessed according to GOST standards; the level of prospects of coniferous species was evaluated using the 7-point visual observation scale of P.I. Lapin and Gusev [2009]; and changes in six landscape indicators of introduced tree species were assessed according to the method of O.Y. Yemelyanova [2011]. Climatic conditions at the experimental site were determined from data from the “Zaamin” meteorological station. Annual precipitation totals 295–405 mm, with 70.4% of precipitation occurring in March–April and October. 50–63% of precipitation falls during the spring period and 6–18% during the summer period. The dry period lasts three months. In the watershed area, the first snow is observed in late September–early October, while in the middle part of the range it occurs in mid-October–early November. Snow cover persists for 60–190 days in the watershed area and for 120–124 days in the middle part of the range. Snowmelt occurs in late March–early April. The soils are dark sierozems; on the slopes of the range, brown forest soils occur. Statistical analysis of the results was performed according to the method of B.A. Dospekhov [1986].



Results and Discussion. In order to expand the range of tree species used to establish protective tree plantations in the mountainous regions of our republic, cultivation of species of the family Pinaceae began in 1970 at the Kulsay Support Station of the Central Asian Research Institute of Forestry (Turkestan Range). These plantings have survived to the present day and continue to grow and develop. In addition to the Kulsay Support Station, landscaping activities using coniferous species were also carried out on the territory of the “Zaamin” sanatorium. The coniferous stands at the “Zaamin” sanatorium were established using seedlings grown in the forest nursery of the Chatkal Mountain Forest Reclamation Experimental Station (Western Tien Shan).

All coniferous trees in the Kulsay area were planted at a spacing of 3×2 m over an area of 4 ha, including Scots pine – 0.24 ha, Crimean pine – 0.54 ha, Norway spruce – 0.42 ha, Schrenk spruce – 1.26 ha, Siberian fir – 0.12 ha, and Siberian larch – 1.42 ha. The overall condition of the stands formed by these species was assessed as good, and they continue to grow at present; i.e., all species exhibit annual increment (see Fig. 1).

Analysis of stem dimensions of the pine species growing at the sites showed that all studied tree species occur in the Kulsay area (Scots pine, Crimean pine, Norway spruce, Schrenk spruce, Siberian fir, and Siberian larch). Tree height was 18.6 ± 0.26 m in Scots pine and 17.8 ± 0.24 m in Crimean pine. Norway spruce reached 18.6 ± 0.23 m, Schrenk spruce – 18.2 ± 0.24 m, Siberian fir – 18.8 ± 0.3 m, and Siberian larch – 16.6 ± 0.24 m. The mean tree diameter was 32.4 ± 0.46 cm in Scots pine, 34.6 ± 0.54 cm in Crimean pine, 26.4 ± 0.34 cm in Norway spruce, 25.8 ± 0.32 cm in Siberian spruce, 27.6 ± 0.26 cm in Siberian fir, and 15.4 ± 0.24 cm in Siberian larch (see Table 1).



Fig. 1. Condition of introduced coniferous trees at the experimental sites (2022–2024)

Table 1. Biometric growth parameters of trees of introduced coniferous species in the Turkestan Range (2024)

No.	Species name	Site name	Elevation above sea level, m	*Age, years	Height, m	Stem diameter, cm
1	Scots pine	Kulsay site	2300	55	18,6±0,26	32,4±0,46
2	Pallas's pine (Crimean pine)	Kulsay site	2300	55	17,8±0,24	34,6±0,54
		Zaamin sanatorium	2000	35	12,4±0,26	28,6±0,42
3	Norway spruce	Kulsay site	2300	55	18,6±0,23	26,4±0,34
		Zaamin sanatorium	2000	35	16,2±0,18	22,4±0,36
4	Schrenk spruce	Kulsay site	2300	55	18,2±0,24	25,8±0,32
5	Siberian fir	Kulsay site	2300	55	18,8±0,3	27,6±0,26
6	Siberian larch	Kulsay site	2300	55	16,6±0,24	15,4±0,24
		Zaamin sanatorium	2000	35	15,2±0,22	26,8±0,32

*Tree age was determined on the basis of information provided by workers employed in the area.

The territory of the Zaamin sanatorium is predominantly occupied by Norway



spruce, Crimean pine, and Siberian larch. Their mean heights are 12.4 ± 0.26 m for Crimean pine, 16.2 ± 0.18 m for Norway spruce, and 15.2 ± 0.22 m for Siberian larch, while the mean stem diameters are 28.6 ± 0.42 cm for Crimean pine, 22.4 ± 0.36 cm for Norway spruce, and 26.8 ± 0.32 cm for Siberian larch (Khamroev Kh.F., Turatov M.N., 2025).



Fig. 2. Larch grove.



Fig. 3. Pine grove

When comparing the other sites, it was found that the introduced coniferous trees growing at the “Kulsay” site (elevation 2,300 m above sea level) were, on average, 1.2–5.4 m taller and 1.2–6.1 cm larger in diameter than the trees growing on the territory of the “Zaamin” sanatorium (elevation 2,000 m above sea level). The Crimean pine showed the greatest difference in height and diameter. This indicates a substantial influence of growing conditions on changes in the mensurational growth parameters of trees.

Phenological studies are of great importance in the study of introduced coniferous species. Phenological observations provide significant assistance in determining the onset of the vegetation period in trees, their transition through different phases, the number of days between them, and the sum of favorable temperatures for their growth.



Bud break in Scots pine was observed on 06 April 2022, 08 April 2023, and 10 April 2024, at an average air temperature of +6.2°C. The onset of shoot growth was observed on 14 April 2022, 16 April 2023, and 22 April 2024, at an average air temperature of +12.4°C. The onset of pollen formation was observed mainly during periods when the average air temperature ranged from +15.2°C to +17.1°C; these periods fell on 12 May 2022, 15 May 2023, and 20 May 2024. In Scots pine, the onset of pollination was observed simultaneously with the onset of pollen formation, occurring on 10 May 2022, 12 May 2023, and 16 May 2024.

The onset of phenological phases in Crimean pine occurred relatively later than in Scots pine: bud break was observed on 08 April 2022, 10 April 2023, and 11 April 2024, with an average air temperature of +6.4°C. The onset of branch growth was observed on 18 April 2022, 18 April 2023, and 23 April 2024, with an average air temperature of +12.6°C. The onset of formation of new needles was observed mainly during periods when the average air temperature ranged from +15.2°C to +17.1°C; these periods fell on 14 May 2022, 15 May 2023, and 22 May 2024. In Crimean pine, as in Scots pine, the onset of pollination was observed simultaneously with the onset of formation of new needles, occurring on 12 May 2022, 14 May 2023, and 20 May 2024 (Turatov M.N., 2025).

Table 2. Development of coniferous species during the vegetation period

Species name	Vegetation period		Vegetation period, days		Shoot growth duration, days		Annual increment, cm	
	2023	2024	2023	2024	2023	2024	2023	2024
Scots pine	04.04 12.10	06.04 12.10	192	190	54	66	6.4	5.8
Pallas's pine (Crimean pine)	06.04 05.10	08.04 14.10	183	190	58	68	10.6	11.4
Norway spruce	07.04 08.10	09.04 18.10	184	193	52	64	4.3	4.6
Schrenk spruce	12.04 16.10	13.04 16.10	189	187	50	60	4.2	4.1
Siberian fir	12.04 12.10	13.04 20.10	185	191	52	61	5.3	5.7
Siberian larch	06.04 08.10	07.04 22.10	186	187	56	65	5.8	6.1



In Norway spruce and Siberian spruce, respectively, bud break occurred on 06 April and 10 April 2022, 07 April and 12 April 2023, and 09 April and 13 April 2024. The air temperature was found to be +6.5°C. In these species, the onset of branch growth was recorded from 14 April, needle formation from 16 May, the onset of pollination from 14 May, cessation of branch growth from 02 June, formation of growth buds from 02 July, and complete lignification of branches began from 02 October.

The onset of vegetation of the tree species at the site was observed in 2023 and 2024. In 2023, vegetation of Scots pine began on 04 April, Crimean pine and Siberian larch – on 06 April, Scots pine – on 07 April, black pine and Scots pine – on 12 April, whereas in 2024 this period began 1–2 days later.

The end of the vegetation period for all species coincided with the second and third decades of October, and the vegetation period lasted 183–193 days. Specifically, the vegetation period lasted 190–192 days for Scots pine, 183–190 days for Crimean pine, 184–193 days for Norway spruce, 189–187 days for Schrenk spruce, 185–191 days for Siberian fir, and 186–187 days for Siberian larch (see Table 2).

It was noted that the duration of branch growth was 50–68 days, with the greatest increment observed in Crimean pine. The duration of its branch growth was 58–68 days, which was 2–8 days longer than in the other species. Accordingly, its annual increment was also higher: annual increment in Crimean pine was 10.6 cm in 2023 and 11.4 cm in 2024 (see Table 2).

Conclusion

1. For the first time, the current condition of six introduced species of the family Pinaceae was monitored, four of which were distinguished by high ornamental value.
2. The studied species differ in the duration of the virginile period. Under the conditions of Uzbekistan, the virginile period was 6–8 years in pine species, 5–7 years in larch, and 6–9 years in spruce and fir species.



3. It was noted that the growth and development parameters under the conditions of the Turkestan Mountain Range were lower than those in their natural distribution areas.

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