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BIOECOLOGICAL ADAPTATION, INTRODUCTION ASSESSMENT AND ORNAMENTAL VALUE OF SELECTED INTRODUCED CONIFEROUS TREE SPECIES

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Abstract
This study evaluates the bioecological adaptation, environmental tolerance, integrated introduction potential, and ornamental performance of six introduced coniferous tree species cultivated in the Turkistan mountain range during 2022-2024. The study considered cold and heat tolerance, response to light, annual shoot lignification, disease and pest resistance, crown-form retention, branching and shoot-growth capacity, generative development, natural regeneration, and seasonal ornamental value. All six species showed high cold tolerance and no visible disease or pest damage. Heat tolerance differed among taxa: Scots pine, Crimean pine, Siberian stone pine, and Siberian larch tolerated 54-57 °C, whereas Norway spruce and Schrenk spruce showed intermediate tolerance at about 52-53 °C. The integrated assessment reported the highest scores for Siberian stone pine (95 points), Scots pine (92), and Crimean pine (92), followed by Siberian larch (82) and the two spruce taxa (64 each). Seasonal ornamental scores exceeded 500 points in five species, while Siberian larch had the lowest annual decorative score because of autumn-winter needle shedding.

Keywords: Coniferous trees, introduction, bioecology, cold tolerance, heat tolerance, ornamental value, landscape design, Pinaceae.

Introduction

The introduction of woody plant species into new climatic and ecological regions requires systematic assessment of their ability to survive, grow, reproduce, and retain stable ornamental characteristics under local conditions. For conifers, adaptation to seasonal temperature variation, light exposure, shoot maturation, and reproductive conditions is especially important because these factors determine long-term biological stability and the value of species for landscape plantings.

The present study examines two complementary aspects of introduced conifers: the response of introduced conifers to environmental factors and their integrated introduction and ornamental assessment. Observations were conducted in the Turkistan mountain range, including the Kulsay plot and the Zomin sanatorium area, during 2022-2024. Six species representing four genera of the family Pinaceae were evaluated: Scots pine (Pinus sylvestris), Crimean pine (Pinus nigra subsp. pallasiana), Norway spruce (Picea abies), Schrenk spruce (Picea schrenkiana), Siberian stone pine (Pinus sibirica), and Siberian larch (Larix sibirica).

RESPONSE OF INTRODUCED CONIFERS TO ENVIRONMENTAL FACTORS

Cold resistance was high across the studied material. In the preliminary cold-resistance assessment, all six taxa were observed without visible winter injury and received the maximum score of 25 points. Needle persistence was also considered because the retention of needles over winter can influence the interpretation of cold damage. Field observations showed that needle retention exceeded three years in all species except Siberian larch, which shed its needles annually. In Siberian larch, cold resistance was additionally assessed from the condition and coloration of one-year-old woody shoots; no cold injury was detected.

Heat resistance was evaluated by the K.A. Akhmatov (1976) procedure described here. Needle samples were exposed to different water temperatures and then transferred to room-temperature water, after which the temperature associated with visible injury to needles and vegetative buds was used as the threshold. The study classifies 54-56 °C and above as resistant, 52-54 °C as moderately resistant, and below 52 °C as sensitive.

In the observations, Norway spruce and Schrenk spruce showed changes in needles and generative buds at 52-53 °C, indicating intermediate heat resistance. The other four species withstood 54-57 °C under the applied procedure. Across the three observation years, the threshold values remained comparatively stable, although Crimean pine reached the highest recorded value of 57 °C in 2024.

The light response was evaluated through visual observations of trees growing under different site conditions. Scots pine, Siberian larch, and Siberian stone pine showed no visible needle discoloration associated with light exposure, whereas partial discoloration was observed in Crimean pine and the spruce taxa. Annual shoot formation and subsequent lignification were also recorded. Pine species generally completed lignification earlier than the other taxa, while Siberian larch showed a slower lignification process.

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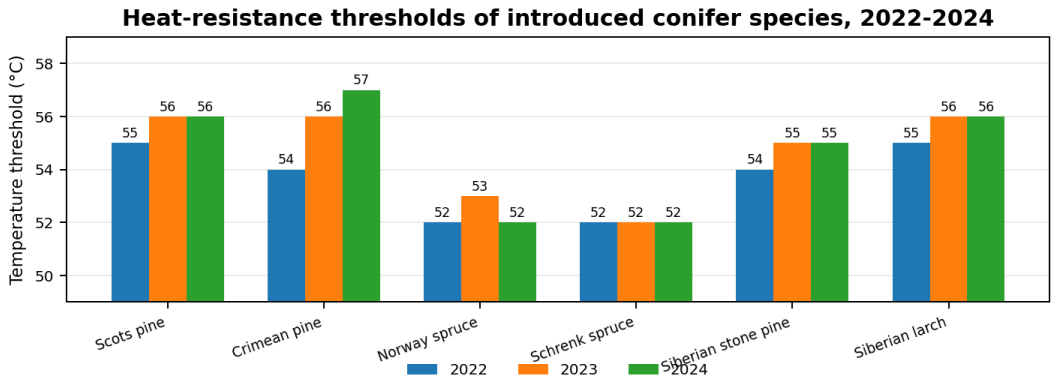

Figure 1. Heat-resistance thresholds of six introduced conifer species during 2022-2024

Table 1. Heat-resistance threshold values of six introduced conifer species, 2022-2024

Species	2022 (°C)	2023 (°C)	2024 (°C)
Scots pine	55	56	56
Crimean pine	54	56	57
Norway spruce	52	53	52
Schrenk spruce	52	52	52
Siberian stone pine	54	55	55
Siberian larch	55	56	56

RESEARCH METHODOLOGY

The research was conducted using direct field observations combined with a laboratory heat-resistance test. The study period covered 2022-2024. The experimental material consisted of six introduced coniferous species belonging to four genera of the *Pinaceae* family and growing under the conditions of the Turkistan mountain range.

Cold resistance was assessed from visible injury to one-, two-, and multi-year above-ground shoots and from needle-retention characteristics. Heat resistance was determined according to the Akhmatov procedure by identifying the temperature at which visible injury appeared in needles and vegetative buds. Light response was assessed visually from changes in needle color under different exposure conditions, while annual shoot lignification was evaluated at the end of the growing season.

Integrated introduction assessment followed the methodology of P.P. Lapin and S.V. Sidneva. The study used nine principal indicators and additionally incorporated disease and pest resistance. Introduced taxa were placed into six groups on a 100-point scale: I, fully promising (91-100); II, promising (76-90); III, less promising (61-75); IV, low promising (41-60); V, not promising (21-40); and VI, unsuitable (5-20). The indicators included shoot lignification, cold and heat resistance, disease and pest resistance, crown-form retention, branching capacity, shoot-growth capacity, generative development, and propagation/natural regeneration.

Seasonal ornamental performance was assessed during 2022-2024, and annual scores were obtained by summing seasonal observations. The study used the resulting annual scores to distinguish highly ornamental species from species with lower decorative stability across the full annual cycle.

RESEARCH RESULTS

Integrated Introduction Assessment

All studied species formed woody annual shoots by the end of the growing season and showed stable crown form. No visible disease or pest damage was observed, so all species received the maximum score for that criterion. Cold resistance was uniformly high. Heat resistance differentiated the species: the two spruce taxa received lower scores because visible injury appeared at 52-53 °C, while the other species were assessed as heat-resistant under the applied criterion.

The reproductive characteristics produced the largest separation among the species. Scots pine, Crimean pine, and Siberian stone pine were reported with full generative scores because seed maturation was observed annually. Norway spruce, Schrenk spruce, and Siberian larch received lower generative scores because flowering occurred without consistent fruit formation. Natural regeneration was clearly recorded only for Siberian stone pine, which was the main factor associated with its highest integrated introduction score.

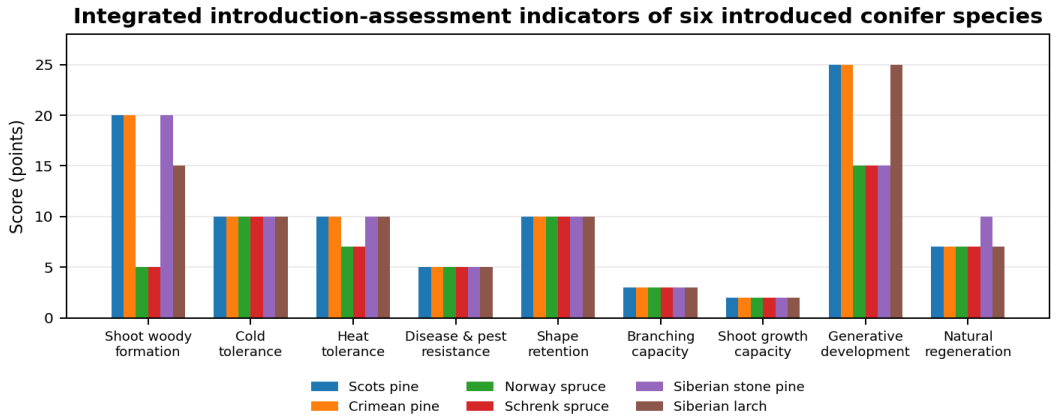

Figure 2. Integrated introduction-assessment indicators of six introduced conifer species, 2022-2024

Table 2. Reported integrated introduction-assessment scores of the six species

Species	Reported total (points)	Assessment group
Scots pine	92	Fully promising
Crimean pine	92	Fully promising
Norway spruce	64	Less promising
Schrenk spruce	64	Less promising
Siberian stone pine	95	Fully promising
Siberian larch	82	Promising

The study reports total integrated scores of 92 points for Scots pine, 92 for Crimean pine, 64 for Norway spruce, 64 for Schrenk spruce, 95 for Siberian stone pine, and 82 for Siberian larch. Accordingly, Scots pine, Crimean pine, and Siberian stone pine were categorized as fully promising; Siberian larch as promising; and Norway spruce and Schrenk spruce as less promising. The particularly high score of Siberian stone pine was associated with its recorded natural regeneration from seed.

Seasonal Ornamental Value and Landscape Performance

Ornamental value was assessed seasonally and summarized for each year. The highest ornamental scores were generally recorded in spring, while the values declined during the hotter summer period under unfavorable climatic conditions. Siberian larch showed a distinct seasonal pattern: annual needle shedding reduced its visual value during the autumn-winter period and consequently lowered the annual total.

Table 3. Seasonal ornamental-value scores of the six introduced conifer species

Species	2022	2023	2024	Observed range
Scots pine	564	582	574	564-582
Crimean pine	582	594	562	562-594
Norway spruce	558	569	584	558-584
Schrenk spruce	534	556	542	534-556
Siberian stone pine	612	628	620	612-628
Siberian larch	430	484	462	430-484

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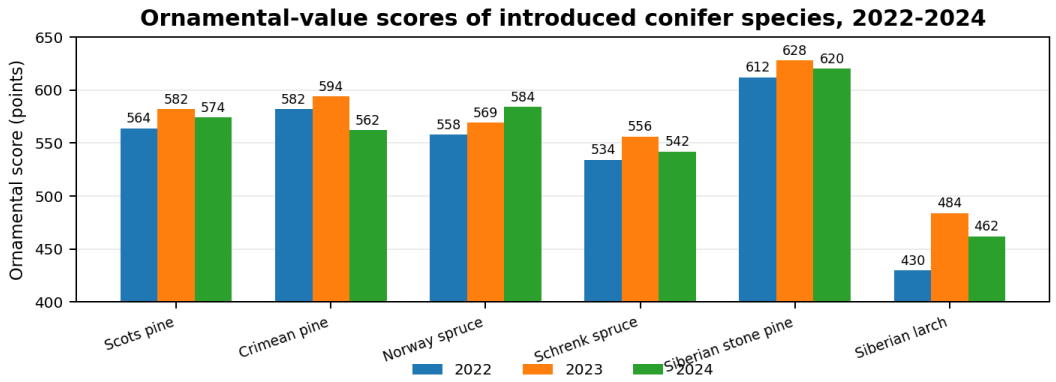

Figure 3. Ornamental-value scores of six introduced conifer species, 2022-2024

Siberian stone pine had the highest ornamental performance, with scores ranging from 612 to 628 points. Crimean pine ranged from 562 to 594 points, Scots pine from 564 to 582, Norway spruce from 558 to 584, and Schrenk spruce from 534 to 556. Siberian larch ranged from 430 to 484 points. According to the study criterion, species exceeding 500 points were classified as highly ornamental; therefore, Scots pine, Crimean pine, Norway spruce, Schrenk spruce, and Siberian stone pine were highly ornamental, whereas Siberian larch was ornamental but comparatively less decorative over the full annual cycle.

DISCUSSION

The combined results indicate that successful introduction of conifers is determined by the interaction of thermal adaptation, vegetative stability, reproductive performance, and seasonal ornamental persistence. The absence of visible cold injury in all six taxa shows that winter conditions at the study sites did not constitute a critical limiting factor during 2022-2024. By contrast, heat tolerance clearly differentiated the spruce taxa from the pines and larch, which is relevant for landscape planning in sites exposed to elevated summer temperatures.

The integrated assessment further demonstrates that high introduction potential is not defined by thermal tolerance alone. Siberian stone pine combined strong environmental stability with high generative performance and recorded natural regeneration, resulting in the highest reported introduction score. Scots pine and Crimean pine also combined high introduction scores with consistently high ornamental values. Siberian larch showed good environmental adaptation and a promising integrated score, but its seasonal needle shedding reduced annual ornamental performance.

From a landscape-design perspective, these differences support a species-specific selection strategy. Scots pine, Crimean pine, and Siberian stone pine are supported by both high introduction scores and high ornamental values. Siberian larch can be valuable where seasonal change is desirable or where its biology is compatible with the design objective. Norway spruce and Schrenk spruce remain usable, but their lower heat tolerance and lower reproductive scores should be considered when selecting sites and planning long-term plantings.

CONCLUSIONS

The 2022-2024 assessment of six introduced coniferous species in the Turkistan mountain range demonstrated a generally high level of environmental adaptation. All species were observed without visible cold injury and without disease or pest damage. Heat tolerance was high in Scots pine, Crimean pine, Siberian stone pine, and Siberian larch, whereas Norway spruce and Schrenk spruce showed intermediate tolerance at 52-53 °C.

The reported integrated introduction scores identified Siberian stone pine (95 points), Scots pine (92), and Crimean pine (92) as fully promising species, Siberian larch (82) as promising, and Norway spruce and Schrenk spruce (64 each) as less promising. Seasonal ornamental scores exceeded 500 points in five taxa, with Siberian stone pine showing the highest ornamental performance and Siberian larch the lowest annual score because of needle shedding during the cold season. These results support differentiated use of introduced conifers in landscape design and further introduction programs, with species selection based jointly on environmental tolerance, reproductive stability, and ornamental persistence.

REFERENCES

1. Akhmatov, K. A. (1976). Methodology used for determining the heat resistance of woody plants,
2. Lapin, P. P., & Sidneva, S. V. Methodology for the integrated assessment of introduced woody plants,