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Taxation Indicators Of Selected Conifer Species (Pinaceae) Introduced In The Turkestan Range, Uzbekistan

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Doctor of Philosophy (PhD) in Biological Sciences

This study evaluates the growth and taxation characteristics of selected conifer species of the Pinaceae family introduced in the Turkestan Range of Uzbekistan. Field observations and forest mensuration were carried out during 2022-2024 in the Kulsay area at 2,300 m above sea level and in the Zomin sanatorium area at 2,000 m. The assessment included stand area and planting scheme, tree height, stem diameter, tree density, cross-sectional area, growing stock and related taxation indicators. In Kulsay, the introduced stands occupied 4.0 ha and all six recorded taxa were planted at a 3 × 2 m scheme. By 2024, mean tree height ranged from 16.6 to 18.8 m and mean stem diameter from 15.4 to 34.6 cm. Siberian stone pine showed the greatest mean height (18.8 m), whereas Crimean pine had the greatest mean diameter (34.6 cm). The results also showed a consistent increase in height and diameter from 2022 to 2024 and higher biometric values in Kulsay than in Zomin for taxa represented at both sites. The findings confirm the long-term establishment of introduced conifers and demonstrate the importance of site conditions when assessing their growth and suitability for protective and landscape plantings.

K E Y W O R D S
Pinaceae; conifers; introduced species; taxation indicators; tree height; stem diameter; Kulsay; Zomin; Turkestan Range; forest mensuration; protective planting; landscape greening

INTRODUCTION

Coniferous trees are widely used in urban greening, protective forestry and landscape improvement because of their durable structure, year-round foliage in evergreen taxa and capacity to form stable tree stands under suitable environmental conditions. Increasing the assortment of species suitable for protective forest plantations and landscape use is therefore an important practical task.

In Uzbekistan, the demand for coniferous planting material and seed resources remains high because conifers are used extensively in greening projects. The introduction of new tree taxa into mountain environments also provides an opportunity to broaden the assortment of species used for protective plantations, recreational landscapes and other planting systems.

cultivation of selected Pinaceae representatives in the Kulsay area of the Turkestan Range began in 1970. In addition to Kulsay, conifers were established in the Zomin sanatorium area, where mature trees originating from planted stock are present. The continued existence and growth of these stands provide a basis for evaluating their present taxation characteristics and multi-year growth dynamics.

Recourse Methodology. The study was based on field observations and forest mensuration conducted during 2022-2024 in two mountain sites of the Turkestan Range: the Kulsay area at an elevation of 2,300 m above sea level and the Zomin sanatorium area at 2,000 m. The investigated taxa were Scots pine, Crimean pine, Norway spruce, Schrenk spruce, Siberian stone pine and Siberian larch in Kulsay; Crimean pine, Norway spruce and Siberian larch were additionally recorded at Zomin.

The evaluated indicators included planting scheme and occupied area, site elevation, estimated tree age, mean height, mean stem diameter, annual changes in height and diameter, number of trees per hectare, cross-sectional area, growing stock and average increment based on stock. Tree ages were compiled by comparison with information provided by workers who had been active in the area. The data were organized for 2022, 2023 and 2024, and the taxation indicators were summarized by species and site.

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Composition, planted area and present condition of introduced stands

Research Results. The introduced conifer stands in the Kulsay area occupied a total of 4.0 ha. All six recorded taxa were established using a 3 × 2 m planting scheme, and the documented condition of each stand was assessed as good. Siberian larch accounted for the largest planted area (1.42 ha), followed by Schrenk spruce (1.26 ha) and Crimean pine (0.54 ha), while Siberian stone pine occupied the smallest area (0.12 ha). The field observations indicate that all recorded stands remained in active growth during the observation period (Table 1; Figure 1).

Table 1. Area, planting scheme and condition of selected introduced conifer stands in the Kulsay area of the Turkestan Range

No.	Tree species	Planting scheme, m	Area, ha	Condition
1	Scots pine	3 × 2	0.24	Good
2	Crimean pine	3 × 2	0.54	Good
3	Norway spruce	3 × 2	0.42	Good
4	Schrenk spruce	3 × 2	1.26	Good
5	Siberian stone pine	3 × 2	0.12	Good
6	Siberian larch	3 × 2	1.42	Good
	Total		4.00	

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Figure 1. Field condition of introduced conifers at the experimental sites (2022-2024)

The field photographs document the established condition of the introduced conifer plantings. The four views show mature stands and individual trees at the experimental sites and visually support the observation that the recorded taxa continued to grow throughout the 2022-2024 study period.

Stem dimensions, site elevation and estimated age

By 2024, the Kulsay trees at 2,300 m displayed substantial stem dimensions despite the mountain environment. Mean tree height varied from 16.6 to 18.8 m, while mean stem diameter ranged from 15.4 to 34.6 cm. Siberian stone pine had the greatest mean height (18.8 m), followed by Scots pine and Norway spruce (18.6 m each). Crimean pine had the greatest mean diameter (34.6 cm) among the taxa measured at Kulsay. At Zomin, the recorded trees were estimated at 35 years of age and included Crimean pine, Norway spruce and Siberian larch, with mean heights of 12.4, 16.2 and 15.2 m, respectively. Kulsay trees were estimated at 55 years of age (Table 2).

Table 2. Stem dimensions of selected introduced conifers in 2024

No.	Tree species	Site	Elevation, m	Estimated age, yr	Mean height, m	Mean diameter, cm
1	Scots pine	Kulsay	2300	55	18.6 ± 0.26	32.4 ± 0.46
2	Crimean pine	Kulsay	2300	55	17.8 ± 0.24	34.6 ± 0.54

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No.	Tree species	Site	Elevation, m	Estimated age, yr	Mean height, m	Mean diameter, cm
2	Crimean pine	Zomin sanatorium	2000	35	12.4 ± 0.26	28.6 ± 0.42
3	Norway spruce	Kulsay	2300	55	18.6 ± 0.23	26.4 ± 0.34
3	Norway spruce	Zomin sanatorium	2000	35	16.2 ± 0.18	22.4 ± 0.36
4	Schrenk spruce	Kulsay	2300	55	18.2 ± 0.24	25.8 ± 0.32
5	Siberian stone pine	Kulsay	2300	55	18.8 ± 0.30	27.6 ± 0.26
6	Siberian larch	Kulsay	2300	55	16.6 ± 0.24	15.4 ± 0.24
6	Siberian larch	Zomin sanatorium	2000	35	15.2 ± 0.22	26.8 ± 0.32

** Estimated age was compiled by comparison with information provided by workers active in the area.*

Height dynamics during 2022-2024

Annual observations showed a consistent upward trend in tree height from 2022 to 2024. At Kulsay, Scots pine increased from 16.8 to 18.6 m, Crimean pine from 16.1 to 17.8 m, Norway spruce from 17.8 to 18.6 m, Schrenk spruce from 17.3 to 18.2 m, Siberian stone pine from 17.8 to 18.8 m, and Siberian larch from 15.5 to 16.6 m. At Zomin, Crimean pine increased from 10.8 to 12.4 m, Norway spruce from 15.3 to 16.2 m, and Siberian larch from 14.3 to 15.2 m (Table 3).

Table 3. Changes in height of selected introduced conifer species, 2022-2024 (m)

No.	Tree species	Site	2022	2023	2024
1	Scots pine	Kulsay	16.8 ± 0.26	17.7 ± 0.26	18.6 ± 0.26
2	Crimean pine	Kulsay	16.1 ± 0.24	17.1 ± 0.24	17.8 ± 0.24
2	Crimean pine	Zomin sanatorium	10.8 ± 0.26	11.9 ± 0.26	12.4 ± 0.26
3	Norway spruce	Kulsay	17.8 ± 0.23	18.3 ± 0.23	18.6 ± 0.23
3	Norway spruce	Zomin sanatorium	15.3 ± 0.18	15.8 ± 0.18	16.2 ± 0.18
4	Schrenk spruce	Kulsay	17.3 ± 0.24	17.8 ± 0.24	18.2 ± 0.24
5	Siberian stone pine	Kulsay	17.8 ± 0.30	18.4 ± 0.30	18.8 ± 0.30
6	Siberian larch	Kulsay	15.5 ± 0.24	16.2 ± 0.24	16.6 ± 0.24
6	Siberian larch	Zomin sanatorium	14.3 ± 0.22	14.8 ± 0.22	15.2 ± 0.22

Taxation characteristics of the Kulsay stands

The taxation assessment demonstrated substantial stand development at Kulsay. The recorded number of trees per hectare ranged from 630 to 830 trees ha^{-1}. Crimean pine had the largest mean diameter (34.6 cm) and the highest taxation coefficient in the recorded data (0.447), while Siberian larch had the highest stocking density (830 trees ha^{-1}). Scots pine recorded the largest cross-sectional area (593.32 m^2 ha^{-1}) and the greatest growing stock (646.4 m^3 ha^{-1}), with Crimean pine close behind at 592.06 m^2 ha^{-1} and 640.8 m^3 ha^{-1}, respectively (Table 4).

Table 4. Taxation indicators of introduced conifer species in the Turkestan Range

No.	Tree species	Trees ha^{-1}	Mean diameter, cm	Mean height, m	Cross-sectional area, m^2 ha^{-1}	Taxation coefficient	Growing stock, m^3 ha^{-1}	Average increment by stock, m^3
1	Scots pine	720	32.4	18.6	593.32	0.435	646.4	7.58
2	Crimean pine	630	34.6	17.8	592.06	0.447	640.8	8.44
3	Norway spruce	810	26.4	18.6	443.16	0.416	562.1	6.52
4	Schrenk spruce	806	25.8	18.2	421.16	0.406	531.6	6.43
5	Siberian stone pine	824	27.6	18.8	492.74	0.367	581.2	6.86
6	Siberian larch	830	26.8	16.6	467.97	0.423	556.7	6.76

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Diameter dynamics during 2022-2024

Stem diameter changed in parallel with height. At Kulsay, Scots pine increased from 31.6 to 32.4 cm, Crimean pine from 33.6 to 34.6 cm, Norway spruce from 25.8 to 26.4 cm, Schrenk spruce from 24.9 to 25.8 cm, Siberian stone pine from 26.8 to 27.6 cm, and Siberian larch from 26.1 to 26.8 cm between 2022 and 2024. At Zomin, Crimean pine increased from 27.5 to 28.6 cm, Norway spruce from 21.7 to 22.4 cm, and Siberian larch from 24.9 to 25.4 cm (Table 5).

Table 5. Changes in diameter of selected introduced conifer species, 2022-2024 (cm)

No.	Tree species	Site	2022	2023	2024
1	Scots pine	Kulsay	31.6 ± 0.46	32.1 ± 0.46	32.4 ± 0.46
2	Crimean pine	Kulsay	33.6 ± 0.54	34.1 ± 0.54	34.6 ± 0.54
2	Crimean pine	Zomin sanatorium	27.5 ± 0.42	28.1 ± 0.42	28.6 ± 0.42
3	Norway spruce	Kulsay	25.8 ± 0.34	26.1 ± 0.34	26.4 ± 0.34
3	Norway spruce	Zomin sanatorium	21.7 ± 0.36	22.1 ± 0.36	22.4 ± 0.36
4	Schrenk spruce	Kulsay	24.9 ± 0.32	25.4 ± 0.32	25.8 ± 0.32
5	Siberian stone pine	Kulsay	26.8 ± 0.26	27.3 ± 0.26	27.6 ± 0.26
6	Siberian larch	Kulsay	26.1 ± 0.32	26.5 ± 0.32	26.8 ± 0.32
6	Siberian larch	Zomin sanatorium	24.9 ± 0.24	25.2 ± 0.24	25.4 ± 0.24

Figure 2. Field measurement of taxation indicators of introduced conifers (2022-2024)

DISCUSSION

The multi-year observations show that the introduced conifers maintained positive height and diameter dynamics throughout 2022-2024. The increase in both indicators across the study period is consistent with continued stand development rather than a decline in growth. Among the Kulsay trees, the highest 2024 height was recorded for Siberian stone pine (18.8 m), while Crimean pine showed the greatest mean stem diameter (34.6 cm).

The comparison between the two sites indicates a clear site effect. Kulsay, located at 2,300 m above sea level, generally produced taller and thicker trees than Zomin, located at 2,000 m, among taxa represented at both sites. The field records reports average differences of 1.2-5.4 m in height and 1.2-6.1 cm in diameter in favor of Kulsay. The largest differences were observed for Crimean pine, suggesting that variation in growth conditions contributes substantially to differences in taxation characteristics.

Stand structure also varied among species. Tree density reached 830 trees ha^{-1} in Siberian larch and 824 trees ha^{-1} in Siberian stone pine, whereas Crimean pine had the lowest density (630 trees ha^{-1}). Scots pine showed the largest cross-sectional area and growing stock, while Crimean pine had the highest taxation coefficient and stock-based average increment in the recorded data. Together, these results indicate that the introduced taxa differ in growth expression and stand-level productivity even within the same mountain region.

Growth pattern and site effect

The 2022-2024 series reveals a sustained increase in height for every taxon recorded at Kulsay. The largest absolute height gain at Kulsay was observed in Scots pine (+1.8 m), followed by Crimean pine (+1.7 m), while Norway spruce increased by 0.8 m. Schrenk spruce, Siberian stone pine and Siberian larch increased by 0.9, 1.0 and 1.1 m, respectively. At Zomin, the height increases were 1.6 m for Crimean pine, 0.9 m for Norway

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spruce and 0.9 m for Siberian larch. The persistence of positive increments in both locations indicates continued development throughout the observation period.

Diameter dynamics followed the same general direction. At Kulsay, the increase between 2022 and 2024 was 0.8 cm in Scots pine, 1.0 cm in Crimean pine, 0.6 cm in Norway spruce, 0.9 cm in Schrenk spruce, 0.8 cm in Siberian stone pine and 0.7 cm in Siberian larch. At Zomin, the corresponding increases were 1.1 cm, 0.7 cm and 0.5 cm for Crimean pine, Norway spruce and Siberian larch. The parallel movement of height and diameter indicates that the stands continued structural development rather than showing a stagnating trend during the three-year period.

The site comparison is especially informative for taxa occurring at both locations. In 2024, Kulsay exceeded Zomin by 5.4 m in Crimean pine height, 2.4 m in Norway spruce height and 1.4 m in Siberian larch height. Diameter differences in favor of Kulsay were 6.0 cm, 4.0 cm and 1.4 cm, respectively. These contrasts, together with the common trend of increasing dimensions, support the conclusion that elevation and associated site conditions have an important role in shaping the observed taxation characteristics of introduced conifers.

Practical implications

The observed performance of the introduced conifers indicates that established mountain plantings can maintain substantial biometric dimensions over long periods when adapted to local site conditions. The Kulsay stands, established since 1970, demonstrate the practical value of retaining and assessing long-established introduced taxa as a source of planting material and as elements of protective forest structure. The differences between Kulsay and Zomin also show that species selection should be linked to the specific elevation and environmental conditions of a planting site.

For protective and landscape applications, the measured stand density and growing-stock values provide useful comparative information for species selection. Scots pine, Crimean pine and Norway spruce combined high height and diameter values at Kulsay, while Siberian larch and Siberian stone pine showed relatively high stocking densities. These characteristics can be considered when developing protective plantations and landscape compositions in mountain areas of Uzbekistan, while recognizing that the present conclusions are based on the observed stands and the taxation data reported for 2022-2024.

CONCLUSIONS

The study confirms the long-term establishment of selected Pinaceae species introduced in the Turkestan Range. In the Kulsay area, six conifer taxa occupied a total of 4.0 ha and remained in good condition under a 3 × 2 m planting scheme. The 2024 mean height values ranged from 16.6 to 18.8 m, and mean stem diameters ranged from 15.4 to 34.6 cm.

From 2022 to 2024, all investigated taxa showed increases in height and stem diameter. Kulsay generally had higher height and diameter values than Zomin for species represented at both sites, with average differences of 1.2-5.4 m in height and 1.2-6.1 cm in diameter. These findings demonstrate that site conditions should be considered when evaluating introduced conifers for protective forestry, landscape greening and related planting systems in mountain environments.

The taxation characteristics further indicate species-specific differences in density, cross-sectional area and growing stock. Scots pine recorded the greatest cross-sectional area and growing stock in the recorded data, while Crimean pine had the highest mean diameter, taxation coefficient and stock-based average increment. The documented performance of these stands provides a practical basis for considering established conifers in future protective and landscape planting programs.

REFERENCES

1. Avery, T. E. (1975). *Natural resources measurements*. McGraw-Hill.
2. Barrett, T. M., Eckmüller, O., Fried, J. S., Lund, H. G., Köhl, M., & Nuutinen, T. (2004). Inventory. In *Encyclopedia of Forest Sciences* (Vol. 1, pp. 403–433). Elsevier.
3. Brack, C. L., Kangas, A., Kangas, J., Mackie, E., Matthews, R., Skovsgaard, J. P., & Worbes, M. (2004). Essays on forest mensuration. In *Encyclopedia of Forest Sciences* (Vol. 2, pp. 550–599). Elsevier.
4. Food and Agriculture Organization of the United Nations. (2004). *National forest inventory: Field manual—Template*. FAO.
5. Food and Agriculture Organization of the United Nations. (2000). *Guidelines for assessments in tropical and subtropical countries: Volume and biomass*. FAO.

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6. Husch, B. (1971). *Planning a forest inventory*. FAO Forestry and Forest Products Study No. 17. Food and Agriculture Organization of the United Nations.
7. Philip, M. S. (1994). *Measuring trees and forests* (2nd ed.). CAB International.
8. Pretzsch, H. (2010). *Forest dynamics, growth and yield: From measurement to model*. Springer.
9. Tomppo, E., Gschwantner, T., Lawrence, M., & McRoberts, R. E. (Eds.). (2010). *National forest inventories: Pathways for common reporting*. Springer.
10. Weiskittel, A. R., Hann, D. W., Kershaw, J. A., Jr., & Vanclay, J. K. (2011). *Forest growth and yield modeling*. Wiley-Blackwell.