

ESTHETIC ASSESSMENT OF THE ORNAMENTAL FORMS OF NORTHERN WHITE CEDAR (*THUJA OCCIDENTALIS* L.) AND THEIR USE IN GARDEN AND PARK COMPOSITIONS

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Abstract: Northern white cedar (*Thuja occidentalis* L.) is represented in the world by about 200 ornamental forms, 43 of which were discovered and described in landscaping and nurseries of Lviv. The first plantations in Lviv date back to the 1920s. They were introduced by the professor at the Medical Institute T. Vilchynskyi, who brought material for cuttings from a nursery in Kurnik (Poland). The decorative qualities of these cultivars were determined on the basis of characteristic features and evaluated in points: the shape and density of the crown, the color of the needles, the nature of branching, and the features of seed-bearing. These decorative qualities formed the basis for the construction of various elements of garden and park compositions with the participation of tapeworms, alleys, green walls, hedges, boskets, topiaries, and rock gardens. The highest number of points (12) was obtained by 46.4% of ornamental forms, 11 – 16.3%, 10 – 9.3%, and 8 – 11.6%. Cultivars with a distinct regular crown shape received high evaluation points. The options for the spatial arrangement of individuals were proposed and the distance between seating positions was recommended. Taking into account the high plasticity of cultivars and the ability to form crowns, variants of clipped hedges and topiaries were recommended. Several models have been proposed based on the distribution of ornamental plant groups based on their symmetry, silhouettes, alignments, contrasts, colors, density, and sizes. Cultivars were selected for each variant, and their group arrangement was proposed.

Key word: northern white cedar (*Thuja occidentalis* L.), ornamental form, landscaping element, composition, esthetic assessment.

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Introduction

Due to the amateur efforts of Prof. T. Vilchynsky, northern white cedar, originating from the Atlantic coast of North America, was introduced in the mild humid climate of Lviv in the 1930s in one columnar and two pyramidal forms (Kharachko and Skolskyi, 2017). A number of pyramidal and columnar forms were introduced during this period. In the post-war period, A. Shcherbyna, an associate professor at the Ivan Franko State University of Lviv, discovered 5 ornamental forms in the landscaping of the city. In the seventies, a large number of cultivars of northern white cedar were introduced by R. Karmazin at the Ivan Franko State University. In the 1970s and 1980s, more than 10 ornamental forms were grown in urban nurseries. Kycheryavyi et al. (2021) found 43 ornamental forms, the vast majority of which are not used in urban landscaping. In our opinion, the main reason for this is the poor awareness among gardeners of the peculiarities of using a rich assortment to create garden and park compositions (Kycheryavyi et al., 2018; Kycheryavyi et al., 2021). *T. occidentalis* attracts the interest of many scientists in the fields of ecology, forestry, and medicine (Landsberg, 1981; Klausnitzer, 1987; Czernecki and Jabłońska, 2016). In particular, the chemical components of *T. occidentalis* have been of interest for decades due to the essential oil, coumarins, flavonoids, tannins, and proanthocyanidins it contains. Pharmacology includes antioxidant, anti-inflammatory, antibacterial, antifungal, antitumor, antiviral, gastrointestinal protective, radioprotective, antipyretic, and regulatory effects on lipid metabolism. *T. occidentalis* is widely used in landscape design. The features of the developmental stage, ornamental values, and varieties of garden hedges used as integral components of landscape architecture and urban design in Kosovo were investigated (Balaj, 2020). It was concluded that the studied varieties of *Thuja sp.* and *Leylandii* species should be included in the structure of the hedge planting for good urban landscape design. Another positive role of the plant was found in the absorption of dust particles from the air. The authors report the degree of absorption of dust particles from the air by some tree species. The presence of wax on the leaves was significant for the adhesion of particulate matter. All species captured dust, with their overall capture efficiency ranked from highest to lowest as follows: *Thuja occidentalis* > *Hedera helix* > *Phyllostachys nigra*. All types of green barriers contributed to the improvement of air quality by capturing dust particles, regardless of their location within the barrier (Redondo-Bermúdez et al., 2021).

The physiological features of growth are of considerable interest in different parts of the world. The study (Bouslimi et al., 2022) examined regional, local, inter-tree, and radial variations in ring density and width in *Thuja occidentalis* in the boreal forest of Quebec. The average ring density of trees growing at Abitibi-Témiscamingue was 356 kg m^{-3} , with slight variation between earlywood and latewood (167 kg m^{-3}), revealing relatively homogeneous wood. Regional and local

variations in growth and wood density parameters of *T. occidentalis* indicate a complex response to environmental factors.

This research reports the results of studies of six old growth stands of northern white cedar (*Thuja occidentalis*) in the Big Reed Reserve in northern Maine, USA, aimed at reconstructing the frequency and severity of past natural disturbances. Overall, 63% of cedar trees contained internal rot, and the likelihood of decay increased with the diameter. Evidence of growth thinning reveals irregular pulses of canopy disturbance with low to moderate severity (Fraver et al., 2020). A study by Johnson et al. (2022) compared seed biomass, morphology, seed set, and similarity between two natural populations and three additional seed sources of *Thuja occidentalis* L. in Chicago, Illinois. Differences between the two adjacent sites indicate that Trout Park (Site 1) is disproportionately affected by environmental factors (e.g., road salt and altered hydrology) compared to Chicago Elementary School (Site 2), potentially affecting the growth and reproduction of *T. occidentalis* in these urban populations. A large dataset of 842 *T. occidentalis* was randomly collected from favorable (cliff-top plateau) and unfavorable (cliff-side) habitats to determine whether trunk streaks were directly or indirectly related to age, growth rate, and habitat (Matthes et al., 2002). The earlywood tracheids of older trees had the most enormous pits, indicating that these trees are more sensitive to cavitation-related scarcity of water than younger trees and supporting the hypothesis that tracheid cavitation is involved in trunk streak formation (Caruntu et al., 2020). Rooting percentage was significantly influenced by the cultivar and type of cuttings, while the root length was significantly influenced by the type of cuttings. A higher average percentage of rooted cuttings was recorded in the cultivar ‘Smaragd’ compared to the cultivar ‘Columna’ (Karlović et al., 2019).

Thuja occidentalis was introduced from North America. Northern white cedar, belonging to the *Cupressaceae* family, is a well-known medicinal and ornamental plant. *Thuja occidentalis*, commonly known as American Arbor vitae or white cedar, is indigenous to eastern North America. It has medicinal properties. The plant was first recognized as a cure by native Indians in Canada during a 16th-century voyage and was found to prove effective in the treatment of weakness from scurvy (Adhikary, 2020). In the countries of North America, the species is found in the wild.

Research on the development of other types of ornamental plants is conducted in the presented region. The peculiarities of under tree microclimate of *Juniperus* L. shrubs are presented. The studied plants were registered within the municipal area of the city of Lviv and its green belt. Temperature and humidity conditions of the under-tree space in summer and winter periods were studied in detail. A comparison of the indices of microclimate under the shrubs and the adjacent open area was carried out (Shuplat and Popovich, 2016).

Morphological features of shrubby stunted and stunted species and forms of junipers make it possible to form a sub-tent phytoclimate in the urbogenic

conditions of the city of Lviv with increased air dryness and temperatures, providing favorable temperature and humidity regimes of air and soil for plants, contributing to the spatial development of bushes, increasing their vitality and decorativeness. The obtained microclimatic data on cloudy and sunny days are characterized by a greater difference in the values of air and soil temperature indicators than on cloudy days (Shuplat and Popovich, 2016).

Material and Methods

The aim was to identify the available cultivars of northern white cedar (*Thuja occidentalis* L.) available in the landscaping and ornamental nurseries of Lviv, determine their shape and color diversity, and evaluate their esthetics.

A route-visual method was used for identifying ornamental forms in landscaping and nurseries (Belochkina, 2006; Kycheryavyi and Kycheryavyi, 2019). The characteristic features of the plants were recorded: the shape and density of the crown, the nature of branching, the color of the needles, and the peculiarities of seed production. A scoring system based on existing methodological approaches was used to evaluate the decorative characteristics of the plants (Shlapak et al., 2014).

The research was conducted during 2015–2022 in the territory of the Lviv region in Ukraine. Figure 1 shows the layout of the studied objects.

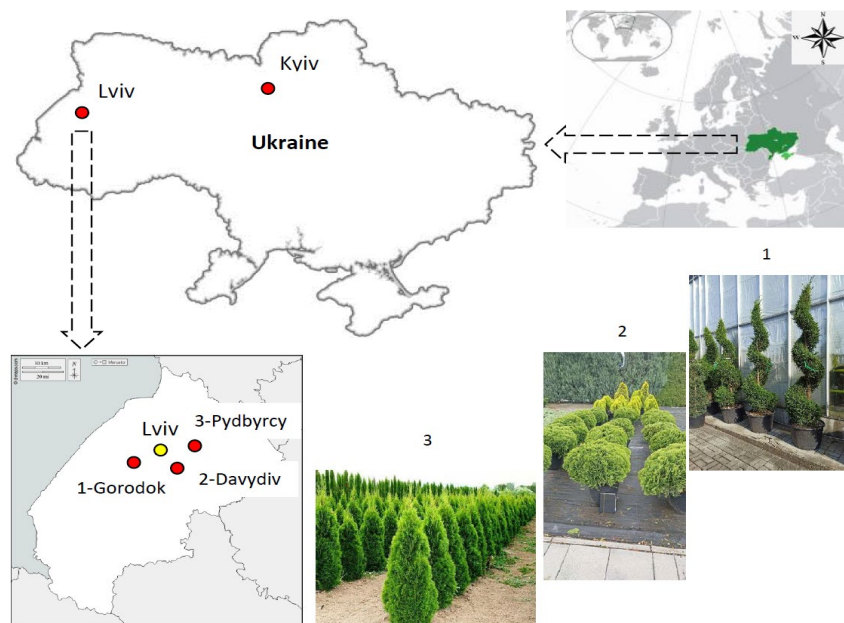


Figure 1. The location scheme of the studied objects within the Lviv region.

Results and Discussion

The wide distribution of ornamental forms of northern white cedar in modern landscaping and nurseries in Lviv is a confirmation of its high esthetics. In general, the decorative qualities of plants are revealed during their development and depend on age, season, location in compositions, and landscaping elements. In this regard, we decided to determine the decorative qualities of its cultivars before designing landscape elements with ornamental forms of northern white cedar. A three-point scale for esthetic evaluation of plants was developed. It takes into account the most characteristic features: crown shape, needle color, branching pattern, seed production, and crown density (Table 1). Forty-three cultivars of northern white cedar were tested by this method (Table 2).

Table 1. The esthetic evaluation of northern white cedar cultivars (point scale).

Crown shape								
Columnar weeping	Pyramidal	Ovoid	Spherical	Pulvinate	Weeping			
3	2	2	3	2	3			
Needle color								
Dark green year-round	Light green year-round	Dark green during the growing season. Color changes in winter	Light green during the growing season. Color changes in winter	Bluish green	Gray-green	Brownish-green	Golden-yellow	White-striped
3	3	2	2	3	2	1	3	3
Branching pattern								
Thin		Medium				Thick		
3		2				1		
Crown density								
Dense		Medium density				Loose		
3		2				1		
Seed production, points								
5	4	3	2			1		
1	1	2	2			3		

Table 2. Summarized data on the esthetic evaluation of the ornamental forms of northern white cedar.

No.	Ornamental form	Biomorph Height, m	Crown shape, point	Needle color, point	Branching pattern, point	Density, point	Total
1.	'Albospicata'	B 5.0	P, 2	Gr., 3	2	2	9
2.	'Aureavarigiata'	T 5.0	P, 2	G, 3	2	2	9
3.	'Aurea'	T 10.0	P, 2	G, 3	2	2	9
4.	'Amberglow'	B 2.0	G, 3	G, 3	3	3	12
5.	'Aureospicata'	B 5.0	G, 2	G, 3	2	2	9
6.	'Aniek'	B 2.0	O, 3	Y, 3	3	3	12
7.	'Bodmeri'	T 5.0	P, 2	Gr., 3	1	1	8
8.	'Brabant'	T 5.0	O, 3	Gr., 3	3	3	12
9.	'Columna'	T 15.0	Col., 3	Gr., 3	3	3	12
10.	'Danica'	B 1.5	G, 3	Gr., 3	3	3	12
11.	'Douglasii Pyramidalis'	T 10.0	P, 3	Gr., 2	3	3	11
12.	'Ellwagneriana'	B 5.0	P, 2	Gr., 2	2	2	8
13.	'Ellwagneriana Aurea'	B 5.0	P, 2	G, 3,	2	1	8
14.	'Ericoides'	B 3.0	P, 2	Gr., 1	2	3	8
15.	'Fastigiata'	T 20.0	Col., 3	Gr., 3	2	3	11
16.	'Filiformis'	B 3.0	P, 3	Gr., 2.	2	2	9
17.	'Globosa'	B 2.5	G, 3	Gr., 2	3	3	11
18.	'Globosa Nana'	B 0.6	G, 3	Gr., 3	3	3	12
19.	'Golden Anne'	B 2.0	P, 3	G, 2	3	3	11
20.	'Golden globe'	B 2.0	G, 3	G, 3	3	3	12
21.	'Hoseri'	B 2.0	Pul., 3	Gr., 3	2	3	11
22.	'Hoveyi'	B 2.0	Pul., 2	Gr., 2	3	3	10

Continuation of Table 2. Summarized data on the esthetic evaluation of the ornamental forms of northern white cedar.

23.	<i>'Holmstrup'</i>	$\frac{T}{10.0}$	Col., 3	Gr., 3	2	2	10
24.	<i>'Jantar'</i>	$\frac{T}{5.0}$	Con., 3	G, 3	3	3	12
25.	<i>'Little Gem'</i>	$\frac{B}{2.0}$	Pul., 3	Gr., 2	2	2	9
26.	<i>'Magic Moment'</i>	$\frac{B}{2.0}$	Col., 3	Gr., 2	3	2	10
27.	<i>'Malonyana'</i>	$\frac{B}{15.0}$	Col., 3	Gr., 3	3	2	11
28.	<i>'Mr. Bowling'</i>	$\frac{B}{2.0}$	G, 3	Gr., 3	3	3	12
29.	<i>'Myriam'</i>	$\frac{B}{2.0}$	G, 3	Gr., 3	3	3	12
30.	<i>'Ohlendorfii'</i>	$\frac{B}{10.5}$	O, 2	Gr., 3	2	2	9
31.	<i>'Pyramidalis'</i>	$\frac{T}{20.0}$	P, 3	Gr, 3	3	3	12
32.	<i>'Pendula'</i>	$\frac{T}{5.0}$	P, 3	G, 3	3	3	12
33.	<i>'Rheingold'</i>	$\frac{B}{5.0}$	O, 3	G, 3	3	3	12
34.	<i>'Smaragd'</i>	$\frac{T}{10.0}$	Col., 3	Gr., 3	3	3	12
35.	<i>'Spiralis'</i>	$\frac{T}{10.0}$	Col., 3	Gr., 3	3	3	12
36.	<i>'Sunkist'</i>	$\frac{T}{5.0}$	Col., 3	G, 3	3	3	12
37.	<i>'Umbraculifera'</i>	$\frac{B}{1.5}$	Pul., 3	Gr., 2	3	3	11
38.	<i>'Variegata'</i>	$\frac{T}{10.0}$	P, 3	G, 3	3	3	12
39.	<i>'Wagnerianna'</i>	$\frac{B}{5.0}$	O, 2	Gr., 2	2	2	8
40.	<i>'Wareana'</i>	$\frac{B}{5.0}$	P, 3	Gr., 2	2	2	9
41.	<i>'Wareana Lutescens'</i>	$\frac{B}{5.0}$	P, 3	G, 3	2	3	11
42.	<i>'Woodwardii'</i>	$\frac{B}{3.0}$	G, 3	Gr., 3	3	3	12
43.	<i>'Yellow Ribbon'</i>	$\frac{T}{3.0}$	Con., 3	G, 3	3	3	12

Remarks: T – tree, B – bush, Col. – columnar, Con. – conical, P – pyramidal, G – globular, O – obovate, Pul. – pulvinate, G – golden, Gr. – green, Y – yellow

The highest number of points (12) was given to 46.4% of the ornamental forms, 11 points to 16.3%, 10 points to 9.3%, and 8 points to 11.6%. Plants with a distinct regular crown shape, primarily columnar and spherical, received a high number of points. They can be widely used in hedges and container plantings, due to their good plasticity. In general, the vast majority (88.4%) of cultivars were characterized by a high decorative index. This indicator is related to the demand and professional selection made by the business. After all, the plant market is supplied with ornamental plants that meet the esthetic tastes of customers.

Design of elements and compositions

The existing compositional solutions of various landscaping elements using analyzed ornamental forms of northern white cedar indicate the lack of standard algorithms developed in forestation (schemes for mixing species). In any case, in modern landscaping, control over these decisions is given to gardening practitioners, who create rather primitive compositions at their own discretion. Because practitioners are unaware of the basic laws and principles of composition, and the richness of forms in dendroflora, they impoverish their psycho-emotional perception when creating plantings. The variants of application of gardening elements in garden and park compositions are suggested.

Solitary

Several possible variants of cultivars of northern white cedar were investigated as solitaires, including both trees and shrubs (Tables 3, 4). We took into account the wind resistance of the plants as well as their high esthetic and sanitary-hygienic properties.

Table 3. Woody forms of northern white cedar as solitaires.

Compositional element	Forms		
	Columnar	Pyramidal golden yellow	Pyramidal
Center solitary	9,15,23,24,27,34,35,36	11	-
Foreground solitary (lawn solitary)	7,26	31	41

In parks, in open spaces, we recommend planting solitary trees with tall columnar (*'Fastigiata'*, *'Columna'*, *'Spiralis'*) and pyramidal (*'Pyramidalis'*, *'Douglasii Pyramidalis'*) shapes in the middle of the lawn or against the background of the forest edge opposite the viewpoint, with a distance of 3–4 m from it, where the tree is a transition from the massif to the lawn. We recommend

introducing golden-yellow forms to contrast with the dark-leaved trees (*'Aurea'*, *'Aureospicata'*, *'Ellwagneriana Aurea'*, *'Wareana Lutescens'*).

We suggest planting the foreground solitaires separately in a place convenient for viewing. We recommend planting them in city squares and small gardens. Low (up to 5 m) columnar, conical, and pyramidal forms of trees and shrubs should be used for planting. The optimal distance from the viewpoint to the exposed solitaires should be two to five times the height of the tree.

Table 4. Shrub forms of northern white cedar as solitaires.

Compositional element	Columnar	Pyramidal	Pyramidal golden yellow	Oval-ovoid	Spherical	Pulvinate	Weeping	Heather-like
Foreground solitary of the group	33	13	2, 3, 4, 13, 33, 39, 43	6	10, 17, 19, 21, 22, 28, 29, 42	25	16	14
Solitary in the branching of the garden path	26, 33	13, 39	13, 4	40	17, 25, 42	-	16	14
Solitary near an architectural object	26	13	-	-	17, 21, 22	-	16	14

We also suggest using shrub forms as solitaires, for accentuating the foreground of a group, branching paths, or decorating an architectural construction.

Alley

Columnar and pyramidal forms, having a vertical impact on the open space, can be used to form compositional axes, accentuate the perimeter of the garden, and create a play of light and shadow.

Alleys with a simple rhythm, when the same shape is repeated at the same distance (*'Fastigiata'*, *'Columna'*, *'Malonyana'*, etc.), are recommended for the entrance areas of parks, squares, and gardens (Table 5).

Table 5. Tree and shrub ornamental forms of northern white cedar in alleys with a simple and complex rhythm.

Compositional element	Possible options
Alley with a simple rhythm (1-1-1...)	9-9-9; 11-11-11; 15-15-15; 27-27-27. 36-36-36; 40-40-40;
Alley with a complex rhythm (1-2-1-2...)	3-17-9; 32-20-32; 35-18-35. 36-29-36; 23-22-23
Alley with a complex rhythm (1-2-2-1-2-2...)	3-10-10-9; 11-12-12-11; 27-28-28-27. 34-30-30-34

The play of light and shadow on the alley with a complex rhythm is represented by: '*Fastigiata*' – '*Hoseri*' – '*Fastigiata*' or '*Columna*' – '*Globosa*' – '*Globosa*' – '*Columna*', etc. Taking into account the possibility of crown growth and competition for light, we recommend planting at a distance of 2.5–3.5 m.

Green wall

Columnar, pyramidal and oval-ovoid shapes (height from 3.0 m to 3.5 m and higher) play a protective role (wind, dust, noise, snow), and also form a fence for various objects – gardens and squares, children's, sports, and household playgrounds, internal boundaries of gardens and allotments. Such walls can be used for visual isolation of unplastered walls and walls with unattractive views.

For green walls, we recommend columnar, pyramidal, and oval-ovoid shapes (Table 6).

Table 6. Woody forms of northern white cedar recommended for green walls.

Compositional element	Shapes			
	Columnar	Pyramidal	Oval-ovoid	Pyramidal golden-yellow
Perimeter for a large area (park)	9; 15; 23; 27	11; 32	40	1; 39
Perimeter for a small area (garden, square)	35; 33; 36;	13; 14; 20; 40	8	14;
Visual fencing	9; 15; 23; 27	11; 32	8	2; 3; 4; 14;

Walls using forms with golden yellow coloring are original. However, mixing green and golden-yellow colors should be avoided. The distance in the row for columnar forms is 0.5 m, for pyramidal – 1.0 m.

Hedges

We recommend using borders, low and medium hedges to frame parterres, flower beds, front gardens, lawns, and paths. Low and medium-height trees and shrubs are suggested (Table 7).

We recommend planting the plants in trenches 50–60 cm deep in a single row (at a distance of 25–35 cm) or in several rows in a checkerboard pattern (spacing in the row 30–40 cm, between rows 20–35 cm).

The topiary work should be carried out at least 4 times during the summer on straight trapezoidal and semi-oval profiles. Despite the simplicity of the rectangular profile, we do not recommend it. Firstly, it forms rigid contours in landscape parks that are not characteristic of a free layout. Secondly, in such hedges, the down part receives less light, which leads to the death of small aerial branches and exposure of the trunks.

Table 7. Forms of northern white cedar recommended for trimmed hedges.

Landscaping elements	Shapes					
	Columnar	Pyramidal	Ovoid	Spherical	Pulvinate	Golden-yellow
Border	23	-	6;12; 16	10; 17; 19	25	5
Low hedge	26	-	6; 12; 30	28; 42; 29	28	20
Medium hedge	35; 36	1; 3	6; 12	-	16	43

Bosquets

Medium-sized hedges in the form of a closed square, rectangle, circle, or other regular shape that delimit a place of rest or exercise, children's playgrounds and sports areas are called bosquets. We recommend upright tree and shrub forms with a dense crown for their creation. The height of the bosquet is 1–2 m. Tending of bosquets (topiary work) is the same as for ordinary hedges (at least 4 times during the summer).

Topiary

Topiaries are a variety of trimmed figures as a tribute to the distant past (this name, according to legend, comes from the name of the ancient Roman gardener Topiarius, a contemporary of Emperor Hadrian [117–138]) (Table 8).

Table 8. Forms of northern white cedar recommended for different types of topiaries.

Compositional elements	Columnar	Pyramidal	Oval-ovoid	Spherical	Pulvinate
Sphere	-	-	-	5; 6; 10; 17; 18; 19; 20; 21; 29; 33	38
Cube	9; 15; 23; 24; 26;34; 35; 36	-	-	-/-	-/-
Cone	-/-	-	40	-/-	-
Pyramid	-/-	32; 39; 41	-	-	-
Drop	35	-	-	18	-
Sphere on the stem	9; 15; 23; 24; 26;34; 35; 36	-	-	-	-
Spiral	-/-	-	-	-	-
Bon-bom	-/-	-	-	-	-
Digit	34	-	22; 33	-	38
Letter	34	-	22; 33	-	38
Animal	-	-	-	17; 18; 19; 20	-

Topiaries are widespread in contemporary landscape gardening art. We have analyzed the modern trimmed decorative forms and proposed plants with good plastic qualities for topiaries.

For topiaries of various decorative and artistic forms, we recommend plants with dense crowns and thin branches pressed against the axial trunk.

Rocky gardens

Ornamental forms of northern white cedar are well represented in rocky gardens today, including spherical and pulvinate forms.

Based on the prospects for this type of landscape gardening, we have proposed ornamental forms suited to the sizes of the gardens (Table 9).

Table 9. Ornamental forms of northern white cedar recommended for rocky gardens.

Rocky garden category	Dimensions, length, m	Recommended ornamental forms
Very small	Up to 5	10, 18, 25
Small	5–15	5, 6, 10, 12, 17, 21, 22, 24, 25
Medium	15–30	5, 6, 10, 12, 14, 16, 17, 18, 19, 20, 21, 24, 25, 28, 29, 31, 39, 43
Big	30–60	1–43
Large	More than 60	1–43

Taking into consideration the scale of the composition, we have selected large-sized plants for small and medium-sized rocky gardens, whereas all 43 cultivars may be used in large and very large gardens. It is recommended to arrange them according to the suggestions of the models.

Conclusion

The high potential of ornamental forms of northern white cedar (88.4% of 43 identified in landscaping and nurseries) makes it possible to increase the estheticization level of green spaces.

Proposals for garden and park elements for decorative compositions (group, solitary, alley, green wall, hedge, bosquet, topiary, rockslide) allow the rational use of planting material, improve esthetics, and increase the durability of plants.

The maximum points (12) were given to 46.4% of the ornamental forms, 11 – 16.3%, 10 – 9.3%, and 8 – 11.6%.

To increase the esthetic value of green spaces with ornamental forms of northern white cedar, it is recommended to use the developed models of compositional grouping based on symmetry, contrast, color, silhouette, crown size, and density.

We have developed possible variants for the use of ornamental forms of northern white cedar as solitaires – 12, alleys with a simple and complex rhythm – 20, green walls – 20, trimmed hedges – 19, topiary – 27, rocky gardens – 43.

References

- Adhikary, K. (2020). Plant with Beneficial Properties *Thuja occidentalis* L. (Cupressaceae) - A Review. *International Journal for Research in Applied Science & Engineering Technology*. 8 (VI), 2407-2409.
- Balaj, N. (2020). *The Impact of Evergreen Hedges Plants (Thuja occidentalis L. and Cupressocyparis leylandii L.) in Garden Structure*. UBT International Conference.
- Belochkina, Y. (2006). *Landscape design*. Kharkiv: FOMO.
- Bouslimi, B., Koubaa, A., & Bergeron, Y. (2022). Regional, Site, and Tree Variations of Wood Density and Growth in *Thuja occidentalis* L. in the Quebec Forest. *Forests*, 13, 1984.
- Caruntu, S., Ciceu, A., Olah, N.K., Don, I., Hermenean, A., & Cotoraci, C. (2020). *Thuja occidentalis* L. (Cupressaceae): Ethnobotany, Phytochemistry and Biological Activity. *Molecules*, 25, 5416.
- Czernecki, B., & Jabłońska, K. (2016). Reconstruction of late spring phenophases in Poland and their response to climate change, 1951–2014. *Acta Agrobotanica*, 69 (2), 1671.
- Fraver, S., Kenefic, L.S., Cutko, A.R., & White, A.S. (2020). Natural disturbance and stand structure of old-growth northern white-cedar (*Thuja occidentalis*) forests, northern Maine, USA. *Forest Ecology and Management*, 456, 117680.
- Johnson, S.A., Janssen, E., Glass, N., Dickerson, P., Whelan, C.J., & Molano-Flores, B. (2022). The role of environmental stressors on reproduction, seed morphology, and germination: a case study of northern white cedar, *Thuja occidentalis* L. *Botany*, 100 (11), 839-847.
- Karlović, K., Antunović, I., & Pecina, M. (2019). Effect of cultivar and type of cuttings on rooting of northern white cedar (*Thuja occidentalis* L.). *Agronomski glasnik*, 81 (4), 239-250.
- Kharachko, T.I., & Skolskyi, I.M. (2017). History and Present-Day Realities of the Botanical Garden of Danylo Halytsky Lviv National Medical University. *Scientific Bulletin of UNFU*, 27 (3), 199-202.
- Klausnitzer, B. (1987). *Ecology of the big city fauna*. Leipzig: World.
- Kycheryavyi, V.S., Popovych, V., Kycheryavyi, V.P., Dyda, O., Shuplat, T., & Bosak, P. (2021). The Influence of Climatic and Edaphic Conditions on the Development of *Thuja occidentalis* 'Smaragd' Under the Urban Conditions of a Large City. *Journal of Ecological Engineering*, 22 (4), 325-332.
- Kycheryavyi, V.P., & Kycheryavyi, V.S. (2019). *Gardening of settlements*. Lviv: Novyi Svit.
- Kycheryavyi, V.P., Popovych, V., & Kycheryavyi, V.S. (2018). The climate of a large city and ecocline ordination of its vegetation cover. *Journal of the Geographical Institute "Jovan Cvijić" SASA*, 68 (2), 177-193.
- Landsberg, H.E. (1981). *The urban climate*. New York, NY: Academic Press.
- Matthes, U., Kelly, P.E., Ryan, C.E., & Larson, D.W. (2002). The Formation and Possible Ecological Function of Stem Strips in *Thuja occidentalis*. *International Journal of Plant Sciences*, 163 (6). <https://doi.org/10.1086/342712>
- Redondo-Bermúdez, M. del C., Gulenc, I.T., Cameron, R.W., & Inkson, B.J. (2021). 'Green barriers' for air pollutant capture: Leaf micromorphology as a mechanism to explain plants capacity to capture particulate matter. *Environmental Pollution*, 288, 117809.
- Shlapak, V.P., Zaplyvana, Y.A., Kurka, S.S., Ishchuk, G.P., & Kulbitsky, V.L. (2014). Arrangement of an alpine hill (alpinarium) on a garden site. *Scientific Bulletin of NLTU of Ukraine*, 24, (6), 19-26.
- Shuplat, T.I., & Popovich, V.V. (2016). Undertree microclimate of Juniper shrubs within the green belt of Lviv city (Ukraine). *Biological Bulletin of Bogdan Chmelnytsky Melitopol State Pedagogical University*, 6 (3), 390-398.

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ESTETSKA OCENA UKRASNIH OBLIKA SEVERNOG BELOG KEDRA
(*THUJA OCCIDENTALIS* L.) I NJIHOVA UPOTREBA U VRTNIM I
PARKOVSKIM KOMPOZICIJAMA

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R e z i m e

Severni beli kedar (*Thuja occidentalis* L.) je u svetu zastupljen sa oko 200 ukrasnih oblika, od kojih su 43 otkrivena i opisana u pejzažnom uređenju i rasadnicima Lavova. Prve plantaže u Lavovu datiraju iz dvadesetih godina 20. veka. Uveo ih je profesor Medicinskog instituta T. Vilčinski, koji je doneo reznice iz rasadnika u Kurniku (Poljska). Dekorativne osobine ovih sorti utvrđivane su na osnovu karakterističnih osobina i ocenjivane bodovima: oblik i gustina krune, boja iglica, način grananja i osobine plodonošenja. Ove dekorativne osobine bile su osnova za izgradnju različitih elemenata vrtnih i parkovskih kompozicija pomoću traka, aleja, zelenih zidova, živih ograda, šumarka, topijara, kamenih vrtova. Najveći broj poena (12) dobilo je 46,4% ornamentalnih formi, 11 – 16,3%, 10 – 9,3% i 8 – 11,6%. Visoke ocene su dobile sorte sa izraženim pravilnim oblikom krune. Predložene su opcije prostornog rasporeda pojedinačnih oblika i preporučena je udaljenost između mesta za sedenje. Uzimajući u obzir visoku plastičnost sorti i sposobnost oblikovanja krune, preporučene su varijante ošišanih živih ograda i topijara. Predloženo je nekoliko modela na osnovu rasporeda grupa ukrasnih biljaka na osnovu njihove simetrije, silueta, usklađenosti, kontrasta, boja, gustine i veličine. Za svaku varijantu odabrane su sorte i predložen je njihov grupni raspored.

Ključne reči: severni beli kedar (*Thuja occidentalis* L.), ukrasni oblik, element pejzaža, kompozicija, estetska ocena.

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