

Research of the Decorative Advantages of Coniferous Trees and Shrubs for Landscaping

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ABSTRACT

Under the arid conditions of chestnut soils of the Volgograd region, the natural populations of coniferous trees are practically absent, and *Juniperus sabina* is present from coniferous shrubs. The introduction of new species of coniferous plants can increase the biodiversity of the flora of the region. The participation of new coniferous species in the greening of settlements can contribute to the formation of comfortable and healthy living conditions for the population. The objects of the study were *Juniperus virginiana* L., *J. sabina* L., *J. communis* L., *Thuja occidentalis* L., *Platycladus orientalis* (L.) Franco, *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco, growing in the nurseries of the Federal Research Center of Agroecology of the Russian Academy of Sciences (Volgograd) and the Lower Volga Station for the selection of tree species (Kamyshin). Within the framework of the study, a scale was formed with a score grading of decorative features. The score-rating score for each species distributed the places in the ranking according to the set of decorative features: 1st place (206 points) – *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco, 2nd place (192 points) – *Juniperus virginiana* L., 3rd place (188 points) – *Platycladus orientalis* (L.) Franco, 4th place (185 points) – *J. sabina* L., *J. communis* L., 5th place (183 points) – *Thuja occidentalis* L. Among a number of studied species, *J. virginiana* L., *T. occidentalis* L. are characterized by the greatest decorativeness and versatility of application., *P. orientalis* (L.) Franco, can be used to create group, single plantings, hedges, and high clipped walls. *J. communis* L., *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco is more recommended for creating group compositional and single plantings. In turn, *J. sabina* L. is recommended for landscaping completely open dry and heavily lit slopes, creating green islands on the lawn.

Keywords: decorative, *Juniperus sabina*, *Juniperus virginiana*, *Juniperus communis*, *Platycladus orientalis*, *Thuja occidentalis*, *Pseudotsuga menziesii*, *glauca*, *viridis*, landscaping, integrated assessment.

INTRODUCTION

In order to implement specific architectural designs and techniques of landscaping settlements, gardeners have to work under different conditions. All this significantly increases the need for ornamental plants that meet a wide variety of requirements. The needs of gardeners can no longer be met by the extremely scarce assortment of trees and shrubs used. The species composition of coniferous trees and shrubs used in landscaping settlements of the Volgograd region is particularly poor.

Every year, the load on natural ecosystems is growing, and landscaping is an important and

necessary element of the improvement of settlements. However, the dynamically changing conditions of urbanized areas are the reason for the reduction of biodiversity, as well as the area of green spaces. In this regard, the selection of an adapted gene pool of economically valuable plants for the formation of protective forest stands for various purposes becomes particularly relevant (Akaberi, 2020).

The expansion of the dendroflora in the greater part is based on the use of exotic plants for this environment. Decorativeness, as an indicator, reflects not only the aesthetic advantages of plants, but also determines the level of adaptation, and resistance to local living conditions. In order to further apply

the concept of decorativeness to plants, it is necessary to assess the properties of individual organs in advance. The evaluation of decorative properties of the studied species was carried out within the framework of the following criteria: crown shape and structure, forking, color of needles, decorative and female cones, and bark color. The period of decorativeness and vital state were also noted (Hoff, 2018).

The aim of the study was to conduct a comprehensive assessment of the ornamental qualities of coniferous trees and shrubs.

The tasks of the research included: development and adaptation of the scale of gradation of features for a comprehensive assessment of decorative properties; identification of the relationship of shoot growth with decorative properties and climatic indicators; rating of decorative advantages of coniferous trees and shrubs and distribution of coniferous trees and shrubs by type of planting.

SCALE OF GRADATIONS OF FEATURES FOR A COMPREHENSIVE ASSESSMENT OF DECORATIVE CONIFEROUS TREES AND SHRUBS

The objects of the study were *Juniperus virginiana* L., *J. sabina* L., *J. communis* L., *Thuja occidentalis* L., *Platyclusus orientalis* (L.) Franco,

Pseudotsuga menziesii var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco, growing in the nursery of the Federal Research Center of Agroecology of the Russian Academy of Sciences (Volgograd) and the Lower Volga Station for the selection of tree species (Kamyshin). The plants were 10–15 years old (Hazubska-Przybył, 2019).

The decorative advantages of woody plants include a range of morphological features. Table 1 shows the key features on the basis of which the characteristics of the studied species are given. When forming a scale with a point gradation, the assessment of decorative features of species of the *Picea* Dieter genus in Northern Kazakhstan was adapted and applied (Table 1).

The comparative characteristics of natural decorative properties of trees and shrubs are formed on the basis of methodological approaches. The layout and adaptation of criteria in the vector of studying coniferous plants was carried out.

Habitus depends on hereditary qualities and external factors acting on the race. The growing conditions and age of plants directly form a large variety of shapes, textures and colors of plants. On the other hand, decorativeness can be considered as an indicator of the adaptation of the same introducers to new conditions. Within the same genus, it can be used to compare the decorative indicators of native and exotic species (García-Cervigón, 2017).

Table 1. Scale of gradations of features for a comprehensive assessment of decorative coniferous trees and shrubs

Attribute	Decorative Score				
	1	2	3	4	5
Flowers	Reduce the decorative effect	Inconspicuous, do not stand out from the General background	Decorative effect is weak, slightly improve the decorative effect of the plant	Mediocre decorativeness. Strongly expressed, but at the same time do not have an aesthetic effect	They stand out Strongly from the General background. Decorative effect is high, increase the overall decorative effect of plants
Decorative features of cones	Reduce the decorative effect	Not noticeable due to their small size, dull with an expressionless color	Faintly visible, briefly enhance the decorative effect	Beautiful, enhance the decorative effect	Clearly stand out against the background of needles, intense bright color
Color of needles	Solid color (green)	Solid color (green), saturated	Solid color with a bluish coating	Weak signs of coloration (from dark green to bluish, bluish)	Pronounced saturated color - bluish, bluish
Bark color	Black, dark gray	Grey, brown, brown	Light gray, light brown	Color (white, yellow, red, green)	Multi-colored
Crown (shape, structure, forking)	Undeveloped or degraded, with a fortificationless than 20% water content	Rare, heterogeneous, forked area 21-50% fortification	Rare, weakly homogeneous, forked area 51-60%	Medium-dense, medium-uniform, fortification 61-80%	Dense, homogeneous, up to 100% water content
The aroma	is Very pronounced unpleasant	Weak, unpleasant	Weak, pleasant	Intense, pleasant	Very strong, pleasant

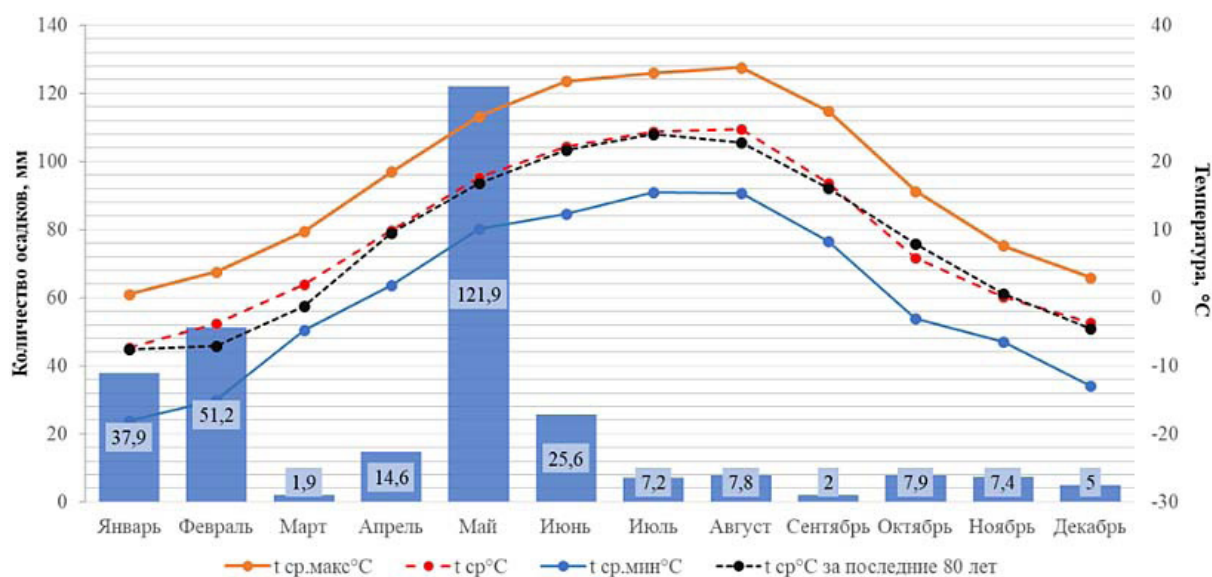


Figure 1. Graph of average monthly air temperatures and monthly precipitation amounts during the year

The objects of research grow in the dry-steppe zone of urbanized territories. The average annual air temperature during the study period was 9.05 °C, which is 1.05 °C higher than normal. The coldest months are January and December. The warmest month is August. The annual precipitation was 290.4 mm – 75% of the norm. It is also worth noting the abnormally low indicators in the autumn and winter period (Fig. 1).

Under the conditions of the abnormally warm period of the study and the lack of precipitation, the studied species showed high water retention rates from 30.5–44.85% of water loss after 24 hours; the water loss for each hour was from 0.28–0.9% (Table 2).

On the basis of the data obtained during the decorative assessment (Table 3), all the studied species can be classified as highly decorative (from 183 to 206 points, in the rating they took 1–5 places) (Table 3).

Decorative period. In a wide range of studies, this period is characterized by the preservation of decorative qualities (decorative crown, needles, cones) over a period of time (García-Cervigón, 2018). On this basis, all the objects of the study received 5 points. Since the presented species belong to evergreen coniferous species, the period of decorative activity is year-round, but the maximum level of decorative activity corresponds to the phenological phase of shoot growth [16, 17]. The longest period of growth of shoots is observed reasonably in the local representative of the flora *J. sabina* L. – 58 days, the shortest period in *J. communis* L. – 41 days, *Pseudotsuga menziesii* (Milb) Franco 55 day, *J. vir-giana* L. – 56 days, *T. occidentalis* L. – 71 days, *P. orientalis* (L.) Franco – 68 days (Table 4).

The shape of the crown. The absolute advantage of evergreen conifers is the relative stability of the habit throughout the year, and the appearance of conifers is also aesthetically fully accepted as a set of branches and deciduous cover

Table 2. Water-holding capacity of coniferous trees and shrubs of annual shoots of the phenological phase Pb4 (completion of shoot growth)

Types	Amount of water lost, % over a period of time								The water content of water content, %
	1H	2H	3h	4h	5h	6h	7h	24h	
<i>J. virginiana</i> L.	3.48	4.07	4.78	5.50	6.12	6.68	7.20	35.71	57.14
<i>J. communis</i> L.	1.54	2.12	2.94	3.84	4.34	5.24	5.96	44.85	50.08
<i>J. sabina</i> L.	2.48	3.19	3.63	4.48	4.92	6.01	6.42	33.28	44.70
<i>T. occidentalis</i> L.	1.29	1.82	2.80	3.42	4.00	4.52	5.03	32.78	48.76
<i>P. orientalis</i> (L.) Franco	2.02	2.52	3.19	3.48	3.83	4.47	5.11	35.47	49.04
<i>Pseudotsuga menziesii</i> (Milb) Franco	2.01	2.3	3.10	3.51	3.95	4.37	5.31	30.5	57.53

Table 3. Assessment of the decorative advantages of the studied species

Decorative attribute and duration of manifestation (month)	Species									
	<i>J. virginiana</i> L.	<i>J. communis</i> L.	<i>J. sabina</i> L.	<i>T. occidentalis</i> L.	<i>P. orientalis</i> (L.) Franco	<i>Pseudotsuga menziesii</i> var. <i>viridis</i> (Schwer.) Franco	<i>P. menziesii</i> var. <i>glauca</i> (Mayr) Franco	<i>Betula pendula</i> Roth	<i>Acer platanoides</i> L.	<i>Robinia pseudoacacia</i> L.
Flowers	2x1	2x1	2x1	2x1	2x1	2x1	2x1	3x1	3x1	5x1
Fruits, cones, and pinecones	cones berries 3x5	3X5	3X5	3x1	3x2	4X3	4x3	3x1	5x3	2x3
Color of needles (leaves)	5X12	4X12	5X12	4X12	5X12	5X12	5X12	5x1	5x1	2x1
Bark	3x12	3x12	3x12	3x12	3x12	3x12	3x12	55x12	4x12	3x12
Crown	5X12	4X12	5X12	5X12	4X12	5X12	5X12	5X12	4x12	3x12
Fragrance	2x12	33x12	1x12	3x12	3x12	3x12	3x12	-	-	1x1
Species rating	197 (2)	185 (4)	185 (4)	183 (5)	188 (3)	206 (1)	206 (1)	131 (6)	119 (7)	86 (8)

of the tree (Table 5). The most versatile species is *J. virginiana* L. due to the variety of crown shapes (pyramidal, cylindrical, egg-shaped). *J. virginiana* L. It is used for the creation of group, single plantings, hedges, as well as high sheared walls. The density of the crown is high, and the bifurcation is uniform.

T. occidentalis L. has a large number of decorative forms, but it is worth noting the cylindrical shape. This form of the crown allows creating vertical lines in the composition, as well as carrying out zoning of the territory, adding completeness and scale to the landscaping project. The density of the crown is high, and the bifurcation is uniform (Huzhahmetova, 2020).

J. communis L., *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco are mostly considered for creating

group compositions and single plantings. It is harmoniously combined with deciduous plants due to the sufficiently loose crown density (Ganguli, 2016).

P. orientalis (L.) Franco is similar to *J. communis* L. in the functional application of crown forms; however, the flat-leafer is less demanding for irrigation and soils. The density of the crown is average, there are gaps.

J. sabina L. is an indigenous representative of the studied species and has the longest period of shoot growth. Promising as landscaping slopes, creating green islands on the lawn. The crown is thick, the forking is uniform.

J. virginiana L. and *J. sabina* L. have dense, smooth, and scaly needles. According to tactile properties, the needles of *J. virginiana* L. are softer and pleasant to the touch (Ogunkunle, 2019). Both junipers have a similar aroma of pine needles, but

Table 4. Correlations of the growth period of shoots with decorative qualities (decade, month)

March			April			May			June			July			View
1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
															<i>J. virginiana</i> L. (1.IV–1.VI)
															<i>J. communis</i> L. (3.IV–1.VI)
															<i>J. sabina</i> L. (3.IV–3.VI)
															<i>T. occidentalis</i> L. (1.V–2.VII)
															<i>P. orientalis</i> (L.) Franco (1.V–2.VII)
															<i>Pseudotsuga menziesii</i> (Milb) Franco

Table 5. Assessment of natural decorative properties of species

Signs	The forms, form						
	<i>J. virginiana</i> L.	<i>J. communis</i> L.	<i>J. sabina</i> L.	<i>T. occidentalis</i> L.	<i>P. orientalis</i> (L.) Franco	<i>Pseudotsuga</i> <i>menziesii</i> var. <i>viridis</i> (Schwer.) Franco	<i>P. menziesii</i> var. <i>glauca</i> (Mayr) Franco
The height of the trees							
Group 1						+	+
Group 2	+				+		
Group 3		+		+			
4 Group							
Group 1 Shrubs							
2 Shrubs Group			+				
3 Group Of Bushes							
Crown shape							
Pand	aramid +	+			+	+	+
Cand	cylindrical +			+			
Aboutrapart							
Egg-shaped	+			+	+		
Arrowyaravena				+			
Self-adhesive			+				
The density of the crowns							
Dense	+	+	+	+			
Semi					-lampshades +	+	+
The openwork							
nature of the development trunks							
Run away							
Full	-wood +	+	+	+	+	+	+
trunk surface Character							
Smooth							
Rough							
Mosaic							
Pitted							
Cracked	+	+	+	+	+	+	+
Scaly							
Warty							
Unfavorable period of the year							
I. DECIDUOUS							
Toevergreen	+	+	+	+	+	+	+
Needle							
II. ANDCHAR SHAPE		+					+
Scaly	+		+	+	+	+	
The texture of pine needles							
III. SMOOTH GLOSSY	+	+	+	+	+	+	+
ΓSmooth matte							
The power of perceiving the aroma of pine needles							
OChen fragrant	+		+	+			
Dearthly		+			+	+	+
Withlabo scented							
Portability of molding trim							
Favorable	+		+	+	+	+	+
Unfavorable		+					

Table 6. The distribution of coniferous trees and shrubs on the types of plantings

Naming of types and forms	Types of landings							
	Arrays	Group Arrays	Tapeworms		Alleyway plantings	Street plantings	Unshaped hedges, edges and borders	Molded hedges
			Foreground	Promising Projects				
<i>Virginiana</i> L. (*, **)	+	+	+		+		+	+
<i>J. communis</i> L. (*, **)		+	+				+	+
<i>J. sabina</i> L. (**)		+	+				+	
<i>T. occidentalis</i> L. (*)		+	+		+			
<i>P. orientalis</i> (L.) Franco (*)		+	+		+	+	+	+
<i>Pseudotsuga menziesii</i> var. <i>viridis</i> (Schwer.) Franco (*)	+	+		+	+			
<i>P. menziesii</i> var. <i>glauca</i> (Mayr) Franco (*)		+	+		+			

note: * – a woody plant, ** – shrub.

the Cossack juniper is characterized by a more saturated and pungent aroma, which causes its toxicity and high content of essential oils among conifers. The color is bright green, does not change throughout the year, always feels “fresh” and saturated externally (Fig. 2, Tables 5, 6).

In *J. communis* L., needle-like soft needles, the color from dark green to green, are preserved throughout the year, the young needles look most contrasting during the growth period of the shoots, creating the effect of “light green brushes” (Kruzhilin, 2018). The aroma of pine needles is unobtrusive and pleasant; it is felt near the plants (Semenyutina, 2019).

The needles of *T. occidentalis* L. and *P. orientalis* (L.) Franco are close-fitting, the keel is absent, due to this feature it seems flattened (lamellar). In *T. occidentalis* L. needles are usually dark green, due to the fact that in the year of the study the amount of precipitation was insufficient and the atmospheric air temperature was higher than normal, yellowing of needles was observed, the aroma is rich and unobtrusive. *P. orientalis* (L.) Franco has a dark green color throughout the year, the smell of needles is felt in the immediate vicinity (Msanne, 2017).

The needles of *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco are soft, thin, green, pointed, most often crescent-shaped, double-rowed. In *Pseudotsuga menziesii* var. *glauca* (Mayr) Franco needles are dense, green with a blue tint, incorrectly double-rowed. The aroma of needles in both representatives is felt in the vicinity of the plants (Lazarev, 2017). Both varieties of false sugi retain a rich color throughout the year (Pérez-Luna, 2020).

This feature, from the point of view of decorativeness, is acceptable a greater extent for tree forms; in shrubs, due to the density of the crown, the bark of trunks and branches is poorly distinguished. The texture and color of the bark of trunks, branches, especially noticeable on leafless areas in different representatives of conifers is peculiar. This feature increases the level of decorativeness, both for individual species and for group plantings (Wang, 2016).

J. communis L., *T. occidentalis* L., *P. orientalis* (L.) Franco have the most uniform texture, the fracturing is uniform and shallow. In *J. communis* L. and *T. occidentalis* L., the bark is exfoliated. *J. virginiana* L., *J. sabina* L. have an inhomogeneous texture of the crust, the fracturing is uneven, and also exfoliates (Fig. 3, Table 5).

J. virginiana L. have gray, cracked light brown bark. In *J. communis* L. the bark is light-grey, cracked and brown; In *J. sabina* L. it is dark gray, cracked red-brown. In *T. occidentalis* L. bark is gray, dark brown in the cracks, and grey in *P. orientalis* (L.) Franco (Fig. 3, Table 5).

The bark of *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco is gray, thick, deeply cracked. *Pseudotsuga menziesii* var. *glauca* (Mayr) Franco also has a gray bark, but it is thin and finely cracked.

J. communis L., *T. occidentalis* L. and *P. orientalis* (L.) Franco, *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco among the studied objects have the most aesthetically attractive texture and color of the bark (Fig. 3).



Figure 2. Needles *J. virginiana* L., *J. communis* L., *J. sabina* L., *T. occidentalis* L., *P. orientalis* (L.) Franco, *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco

Tolerance of mold pruning

All the studied species, with the exception of *J. communis* L. perfectly tolerate molding pruning. Molding pruning, if necessary, allows forming a uniform arrangement of the main branches, strengthening the growth of side shoots and increasing the density of the crown (Singh, 2020).

Acknowledgements

The research was carried out within the framework of the state task No. 0713-2019-0004 “To develop scientific foundations and methods for preserving the biodiversity of tree species in order to select an adapted gene pool of economically valuable

plants for the formation of protective forest stands for various purposes in the steppe and semi-desert” (state registration No.AAAA-A16-116032950058-8) funded by the Ministry of Science and Higher Education of the Russian Federation.

CONCLUSIONS

The developed complex decorative assessment is recommended for use in various types of plantings of the following species: *Juniperus virginiana* L., *J. sabina* L., *J. communis* L., *Thuja occidentalis* L., *Platycladus orientalis* (L.) Franco, *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii*

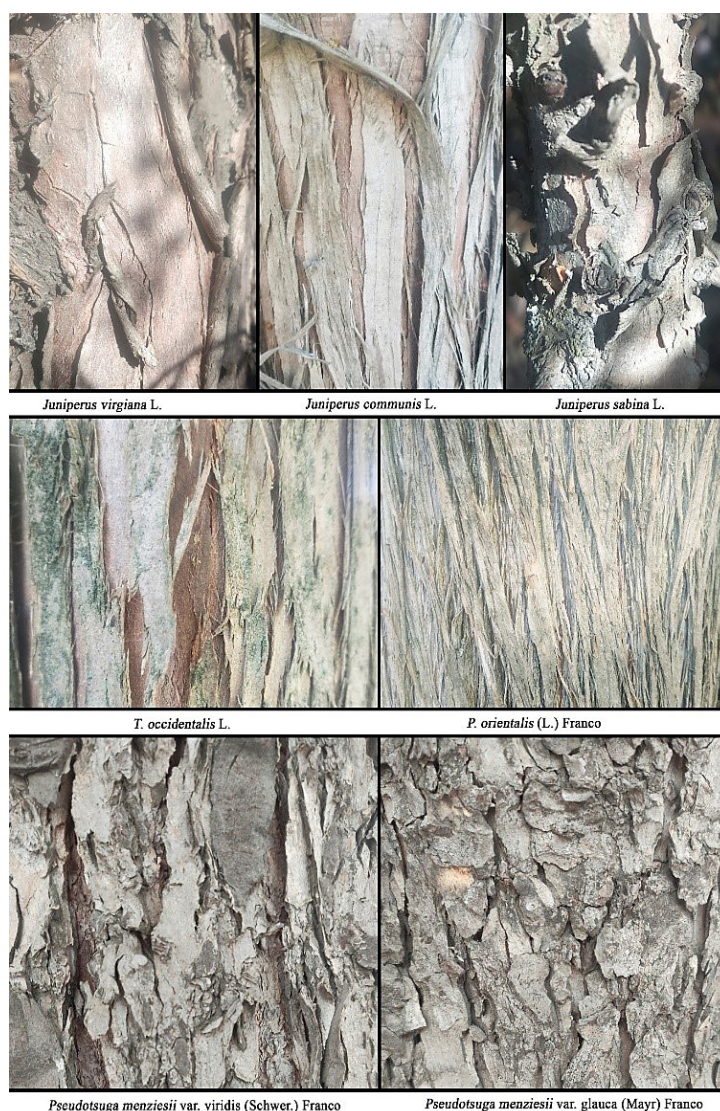


Figure 3. Cora *J. virginiana* L., *J. communis* L., *J. sabina* L., *T. occidentalis* L., *P. orientalis* (L.) Franco, *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco

var. *glauca* (Mayr) Franco under the conditions of chestnut soils of the Volgograd region.

It was revealed that all the studied species belong to a highly decorative group of plants that preserve aesthetic qualities throughout the year. Under climatic conditions, the average annual air temperature is above the norm by 1.05°C, the annual precipitation of 290.4 mm is 75% of the norm. The duration of growth of shoots is as follows: *J. sabina* L.– 58 days, *J. communis* L. – 41 days, *Pseudotsuga menziesii* (Milb) Franco – 55 days, *J. virginiana* L. – 56 days, *T. occidentalis* L. – 71 days, *P. orientalis* (L.) Franco – 68 days.

The rating was compiled according to the set of decorative features: 1st place (206 points) – *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco, 2nd place (192 points) – *Juniperus virginiana*

L., 3rd place (188 points) – *Platycladus orientalis* (L.) Franco, 4th place (185 points) – *J. sabina* L., *J. communis* L., 5th place (183 points) – *Thuja occidentalis* L.

The use of *J. communis* L., *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco and *J. sabina* L. as landscaping objects is limited due to the peculiarities of life forms. *J. communis* L., *Pseudotsuga menziesii* var. *viridis* (Schwer.) Franco, *P. menziesii* var. *glauca* (Mayr) Franco are mostly considered for creating group compositional and single plantings. *J. communis* L. is the only one of the studied species that does not tolerate molding pruning. This species is not inferior in decorative qualities to *T. occidentalis* L., *P. orientalis* (L.) Franco, *J. virginiana* L.. However, in unfavorable hydrological years, due to low precipitation, the

plant is depressed, the needles become dull, hanging and rough. *J. sabina* L. – a local representative of the flora, has the longest period of growth of shoots, it is recommended to use for landscaping completely open dry and heavily lit slopes, creating green islands on the lawn. The representative is unpretentious, characterized by high resistance to abnormally high air temperatures and small amounts of precipitation.

The studied plant sites have a huge potential for increasing biodiversity. Decorative properties, which are manifested in the natural habitats of exotics, are fully revealed under the conditions of chestnut soils of the Volgograd region. They can contribute to the formation of a comfortable and healthy environment.

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