Usage practicability of acer l. Species in landscaping in the central part of Rostov region

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Abstract

Short-lived fast-growing and non-forming dense shadow woody species, more than 60% , dominate in the forestlands and the total mass of landscaping of urbanized territories of Rostov region. Durable species account for less than 18%. At the same time they are these species that create more comfortable conditions for recreation in the steppe zone due to the dense crown (Teodoronski, 2010). The reasons for such low participation of durable plants in urban planting of greenery are the lack of study of their bioecological potential and adaptation capabilities in an arid region, and the difficulty of planting material culture.

The crucial task is bioecological justification of the possibility of expanding biodiversity in landscaping of public objects (parks, squares, avenues, street plantations) and clarification of recommendations to implement landscaping involving species of the Acer L. genus.

The aim of the research is a comprehensive assessment of the state of woody species of the Acer L. genus and the development of methods to increase the stability and ornamental durability of maple plantations at the public landscaping sites of Rostov agglomeration.

The objects of research were uneven aged plantations with the share of Bosnian maple (Acer platanoides L.) and its spherical form (Acer platanoides "Globosum"), sycamore maple (Acer pseudoplatanus L.) and silver maple (Acer saccharum) located on the items of landscaping (parks, squares, avenues, streets) of Rostov region.

The research revealed that the area of green plantations of Rostov region tends to decrease while the area of urban territory and population has increased by 7.8 and 3.3 times respectively since 1980.

The area of landscaping public use plantations with participation of representatives of the Acer L. genus in Rostov region is 11.42 hectares. Among them there are 62.46% at the age of 51 to 80 years old. The participation share of Acer platanoides L. varies between 8.1-10.2, A. pseudoplcitcinus L. 3.0-4.4, specificallyt A. saccharinum L. 0.4-1.7, A. platanoides "Globosum" 1.1-5.4%.

Keywords

Acer L. (maple), landscaping, public use items, park, square, avenue, street plantings, durability, dry steppe, luminosity, cluster analysis.

Introduction

Maples are among the best ornamental trees used in landscaping of settlements in Russia and abroad. They are highly resistant to urban air pollution.

Drought resistance and wind resistance of maples allow to use them in reclamation of agro- and urban landscapes. Maples improve water and meliorative soils properties well.

Research materials and methods

The objects of research were landscaping plantations of different age with participation of Bosnian maple (Acer platanoides L.) and its spherical form (Acer platanoides "Globosum"), sycamore maple (Acer pseudoplatanus L.) and silver maple (Acer saccharum) located on the objects of landscaping (parks, squares Avenues, streets) of Rostov region.

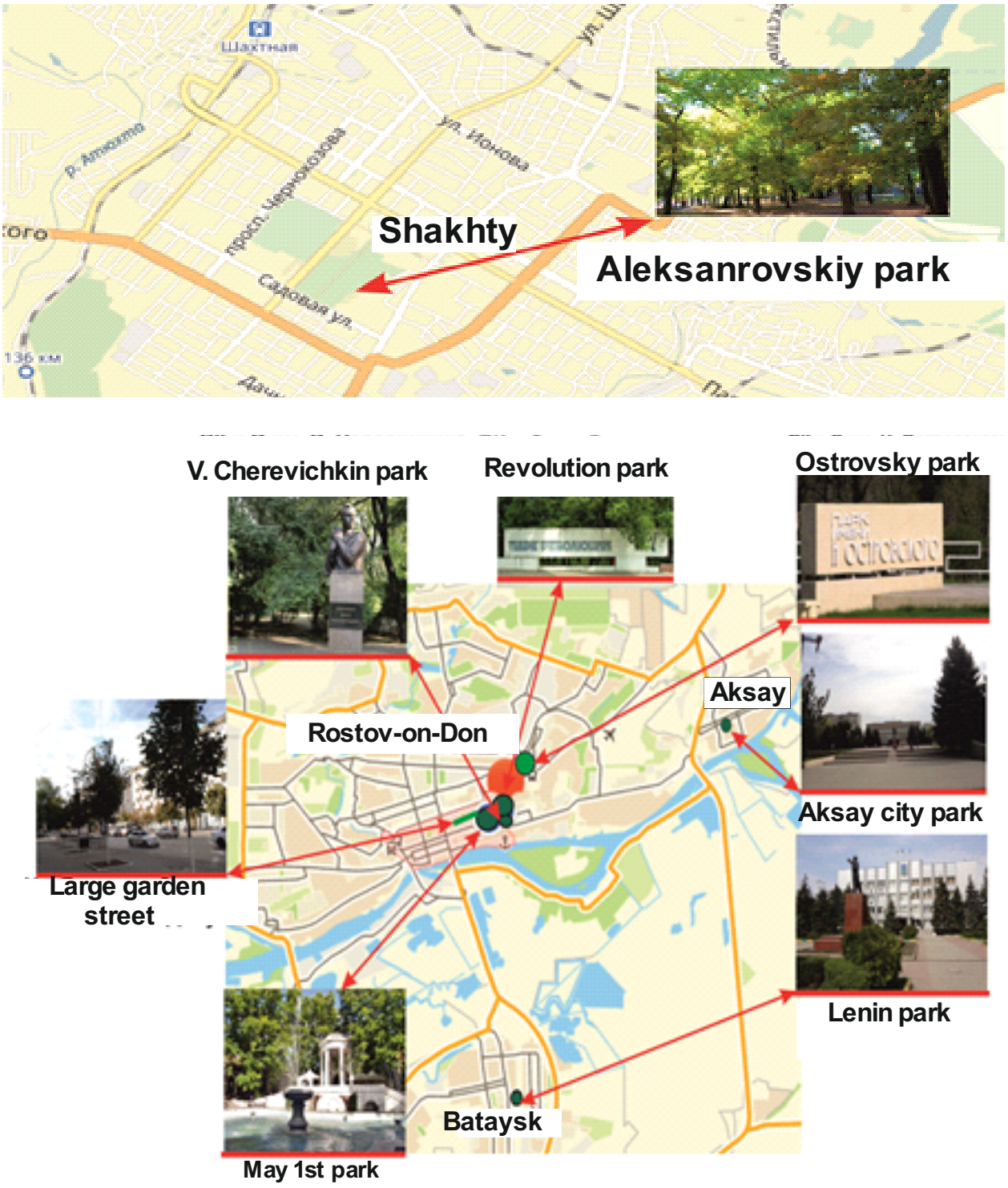


Figure 1. Layout of the main research objects

Material analysis of the inventory of objects of greenery of public usage in the towns of Rostov agglomeration revealed that the area of landscaped plantations tends to decrease, and the area of urban territory and population increased by 7.8 and 3.3 times respectively since 1980.

Results and discussions

Plantations involving species of the Acer L. genus in Rostov region account for 11.42 hectares and about 27.5 thousand trees. Share of Acer platanoides L. in public use plantations ranges from 8.1to10.2, Acer

pseudoplatanus L. from 3.0 to 4.4, Acer saccharinum L. from 0.4to 1.7, Acer platanoides "Globosum" from1.1to 5.4% (Figure 2).

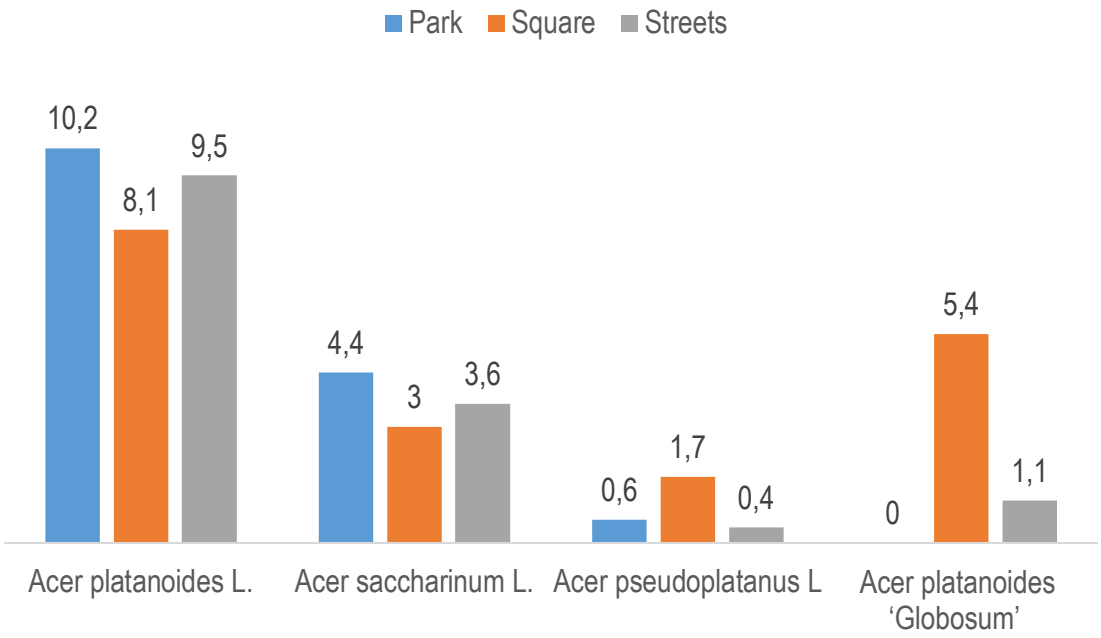


Figure 2. Average participation share of species of the Acer L. genus in garden and park plantations, (%)

They are represented by different types of plantations such as groups, alleys, arrays on the landscaping items of Rostov region.

Figure 3. Alley plantation of Bosnian maple

Studied representatives of the genus Acer L. in the conditions of Rostov agglomeration proved to be promising species for the landscaping purposes. Species of the Acer L. genus are able to resist a complex of adverse winter period conditions. The obtained average values of winter resistance points are: Acer pseudoplatanus L. is 4.60; A. platanoides L. is 4.31 and A. saccharinum L. is 3.72. Acer pseudoplatanus L. has the best drought and heat resistant points (4.66 and 4.46 respectively) compared to other species. Acer saccharinum L. has the worst average state point of 3.82 (Table 1).

Table 1. Complex state assessment of woody species Acer L. genus
(S.S. Taran, I.S. Kolganova, 2013 (Taran, 2013))

Sample plot №	Indices, point					
	Winter resistance	Drought resistance	Heat resistance	Disease resistance	Reproductive ability	State
Acer pseudoplatanus L.						
Average	4.60±0.1	4.66±0.1	4.46±0.1	4.45±0.1	4.58±0.1	4.55±0.1
Acer platanoides L.						
Average	4.31±0.1	4.25±0.1	4.19±0.1	4.23±0.1	4.33±0.1	4.26±0.1
Acer platanoides 'Globosum'						
Average	4.41±0.1	4.40±0.1	4.20±0.1	3.90±0.1	3.51±0.1	4.08±0.1
Acer saccharinum L.						
Average	3.72±0.1	3.88±0.1	3.96±0.3	3.63±0.2	3.93±0.3	3.82±0.2

Compositional selection of plant material is determined by the purpose of the designed landscape and requires appropriate differences in creation. Age-related changes in plant size are essential at selecting plants as specimen trees and into compositional groups.

The height of Bosnian maple in conditions of the research area can reach the following indices: at the age of 42 years - 6.8 m; 62 years - 7.2 m; 74 years - 9.84 m; 80 years - 8.8 m.

Sycamore maple grows successfully in urban conditions reaching the average height of 7.42 m by the age of 46years old in Rostov-on-Don and 6.9 m by the age of 49 years old in Novocherkassk, trunk diameter is 22.0 and 23.9 cm respectively. The larger height at a younger age in Rostov-on-Don compared to Novocherkassk is explained by the larger initial and actual density in Rostov-on-Don that contributes to the acceleration of height growth and the reduction of growth rate in diameter.

Changing of the age related growth indices of Acer L. species representatives is described by the following equations (Table 2).

Table 2. Regression equations describing the growth of maple species in greenery plantations by height and diameter (age limit from 5 to 60 years old)

Maple species	Index	Regression equation (correlation index)
A. platanoides L.	height	y = 0.094 x + 2.7687 (r=0.975)
	diameter	y = 1.999 x + 7.02 (r=0.645)
A. saccharinum L.	height	y = 0.112 x + 3.042 (r=0.975)
	diameter	y = 0.669 x + 0.694 (r=0.985)

Silver maple is the fastest growing maple of the region, by the age of 52 years the average sizes are the following: height is 8. 84 ± 0.1 m, diameter is 38.78 ± 0.2 cm.

Optimal development and demonstration of ornamental qualities in conditions of dry steppe and semi-desert achieve species which growth, development and attitude to the limiting factors correspond to ecological indicators of urban environment. Plantations at the age of more than 60 years old need to be treated.

Knowledge of the terms of phenological phases makes it possible to select plants into compositional groups which provide a long decorative effect replacing each other during the vegetative period.

Phenological phases are closely related to physiological and biochemical changes, the course of which in its turn is due to the rhythm of the outer environment. Depending on lability or stability of the seasonal

rhythm the duration of each stage depends on the possibility and successfulness of the species growing in new conditions.

The studied species of Acer L. differ from each other in seasonal development rhythm. The distribution regularities of phenological dates are characterized by a high degree of density and involve the sum of effective temperatures.

Leaves are the leading factor at designing of park compositions as they enhance the ornamental effect of the entire wood plant, and their colour is the main tool in the creation of "aerial perspective" and contrasting colour solutions. Ornamental foliage of species of the Acer L. genus is an important indicator; in summer it is dark green, in autumn it is of red gold colour, light yellow or with a reddish hint (Kolesnikov, 1974). Table 4.3 represents the average dates of the foliage development phases from the beginning of the foliation to the total loss and the sum of the effective corresponding temperatures.

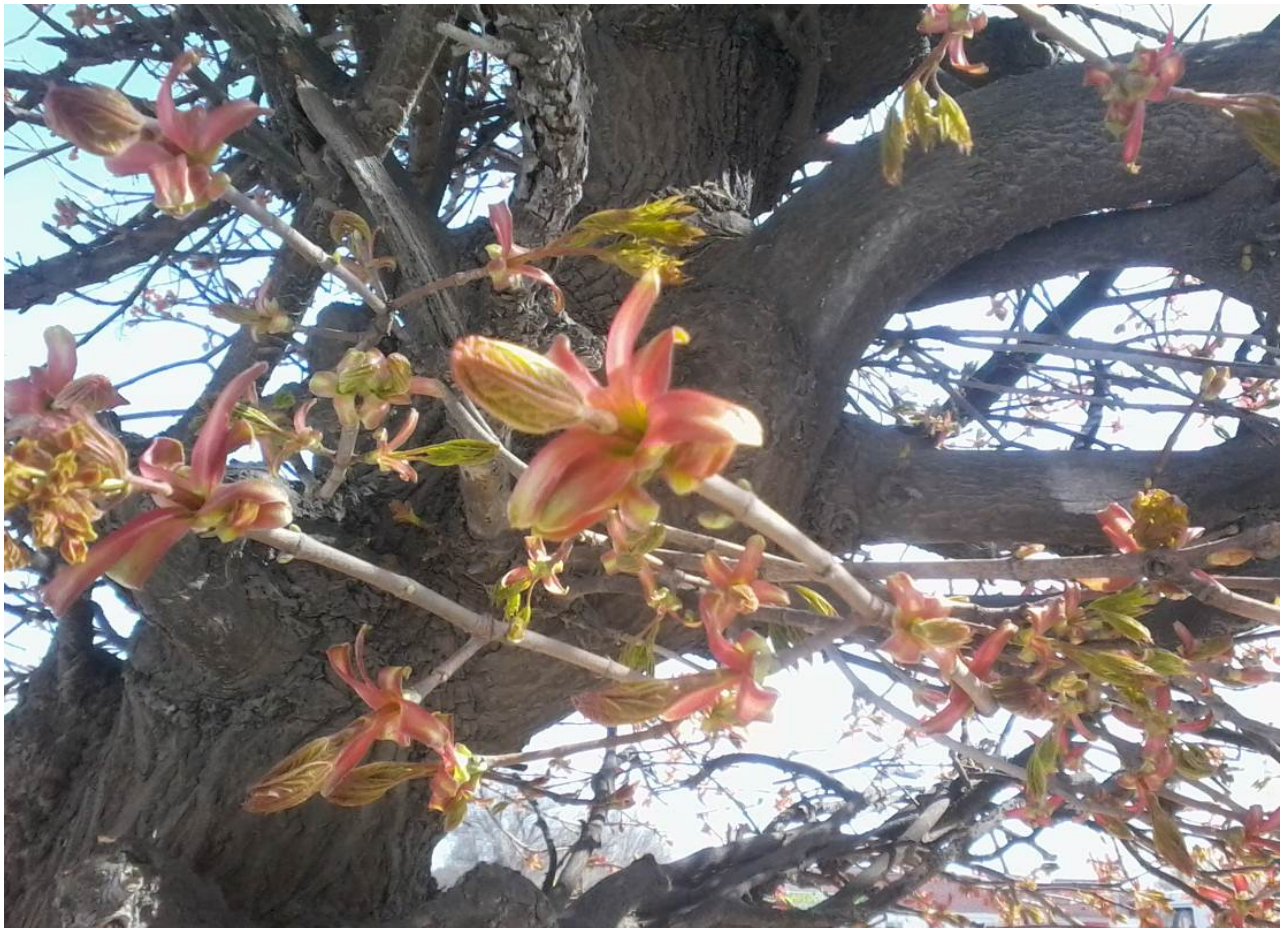


Figure 4. Beginning of foliation of Acer platanoides L.

Perfect ornamental state of Acer L. tree species in Rostov agglomeration is determined by the size and shape of the crown, leaves are an additional element that has a significant impact on the crown shape. Short-term seasonal changes in the texture of the crown cover are introduced by flowers and fruits.

When forming maple plantations for recreational purposes it is necessary to have a quality lawn covering which depends on the luminosity conditions (Table 5,6).

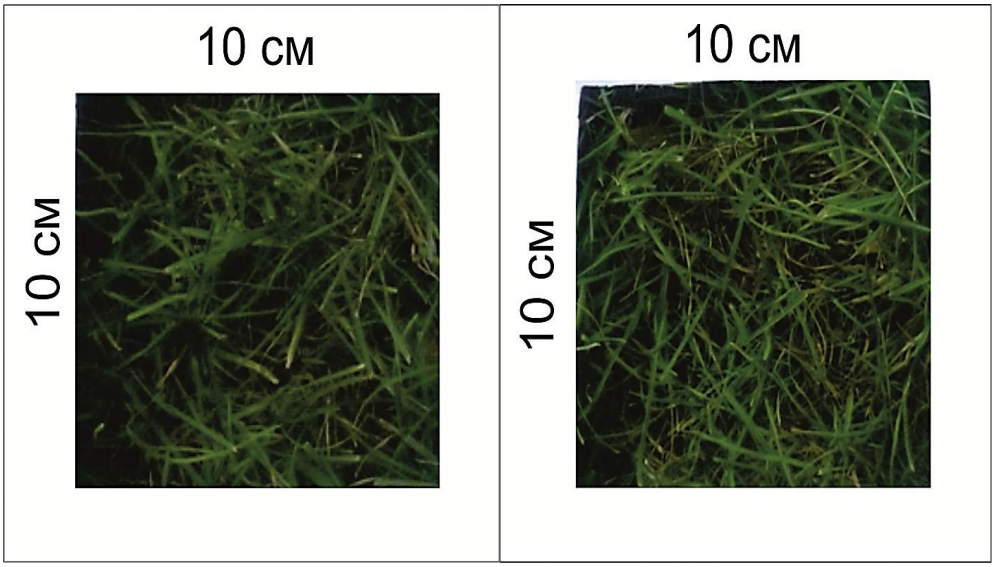


Figure 5. Density of the lawn covering on the open space and on the crown fringe

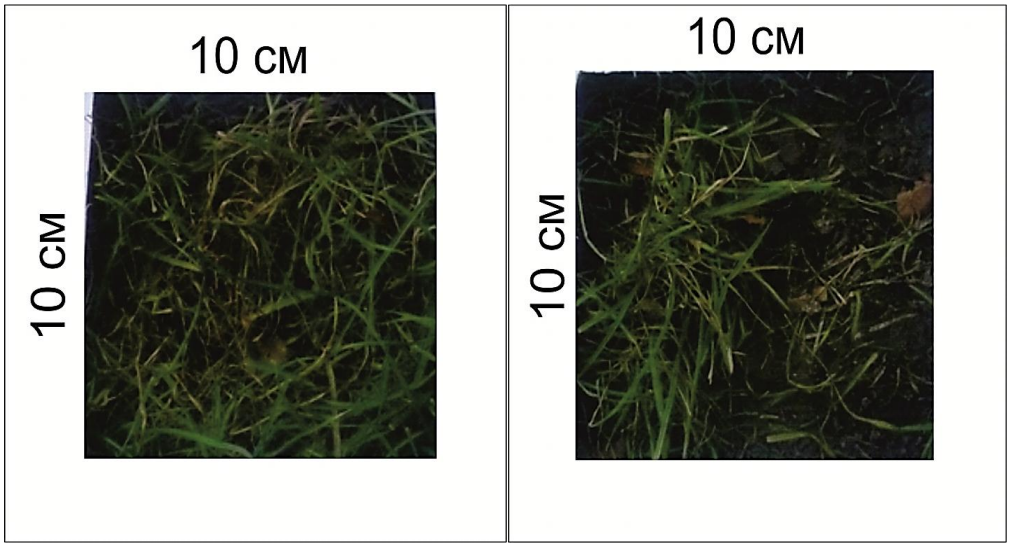


Figure 6. Density of the lawn covering in the crown center and near the trunk

Reduction of average luminosity to 6979.1 lx is tolerated by lawn covering without significant loss of ornamental qualities. Further decrease in luminosity level causes significant attraction decrease.

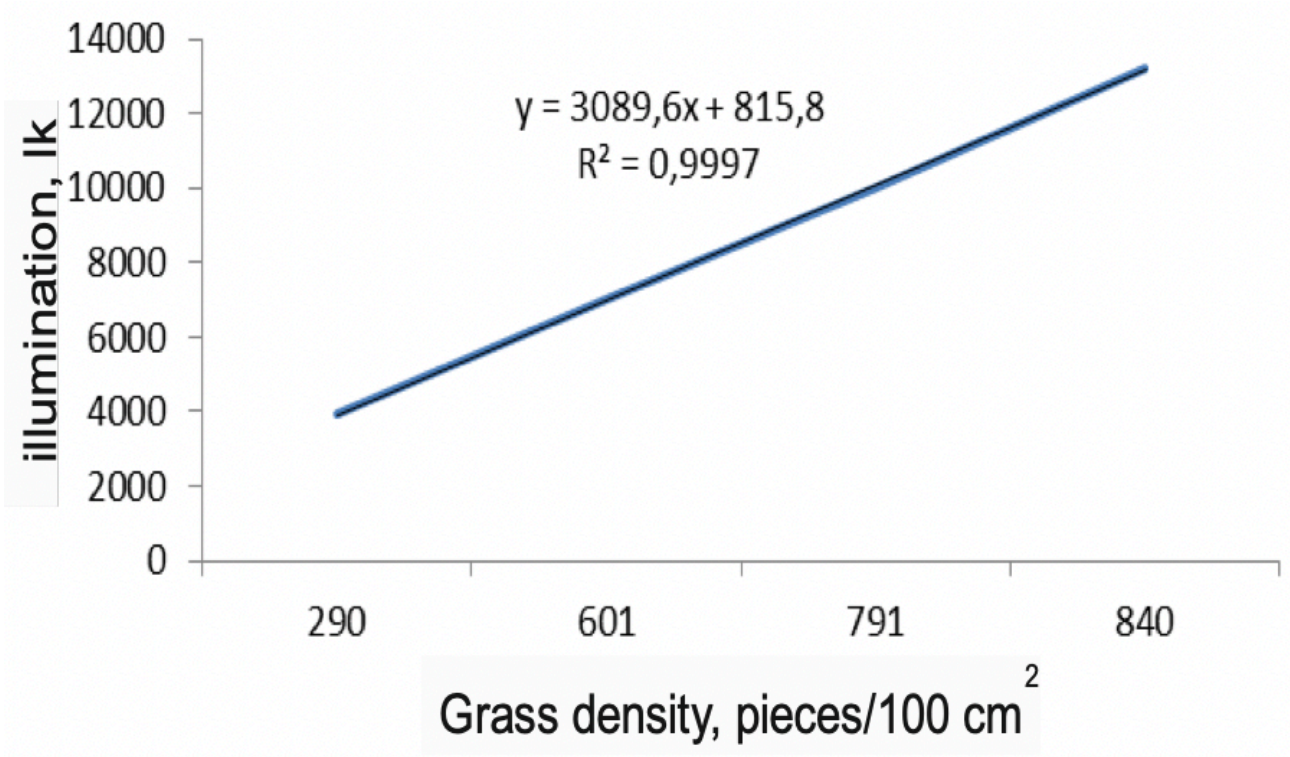


Figure 7. Dependence of lawn covering density on the level of surface luminosity

In addition, the nature of luminosity under the canopy of the Acer L. plantation affects such ornamental feature of landscape architecture objects as the lawn cover density, which decreases as it approaches the tree trunk. The minimum value of luminosity under the canopy ensuring preservation of ornamental lawn density is 6978.1 lx, at the same time the lawn density decreases by 28.5%.

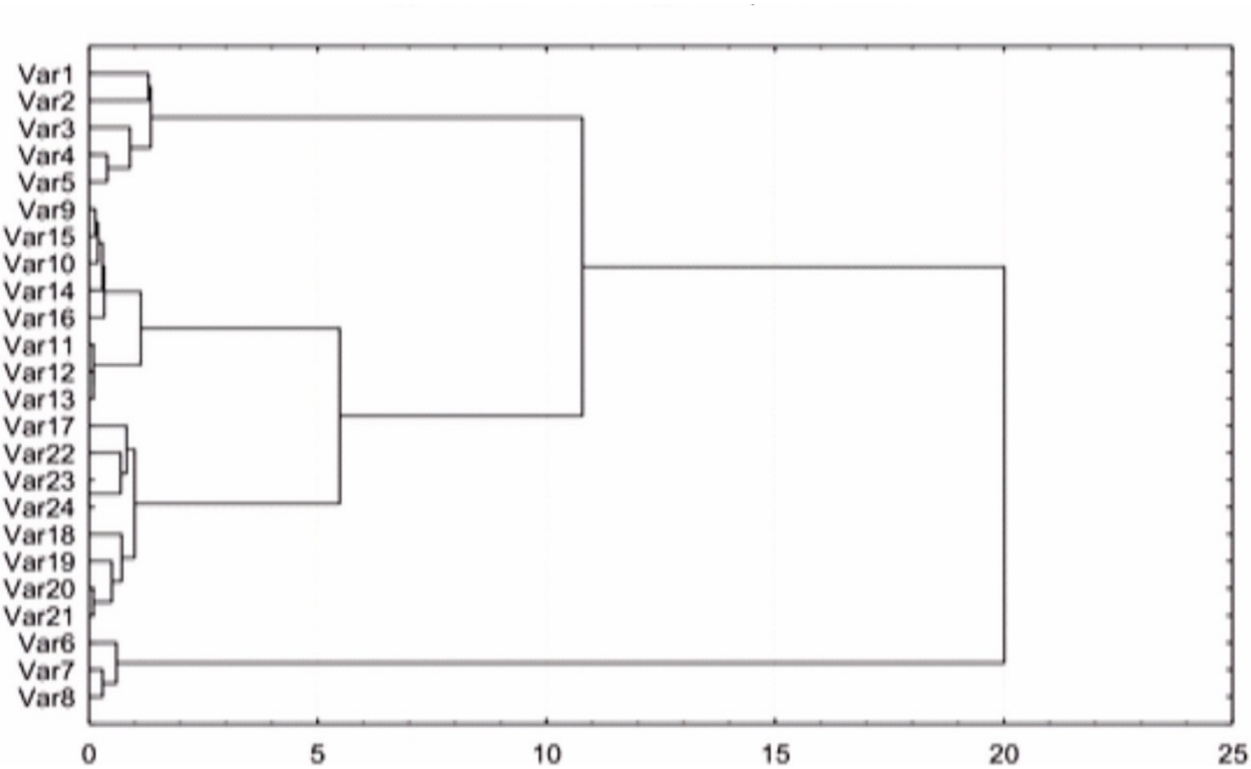
Plant selection when creating garden and park compositions is determined by the target purpose of the designed landscape. Thus, the plant assortment for urban public objects (park, square, boulevard, etc.) will be fundamentally different than for forest park or recreational zones of protected areas. In the process of plant selection a number of fundamental principles is observed: ecological comfort, biological resource potential, decorative durability, harmonic selection of the assortment of resistant and ornamental woody plants.

To identify the biological resource potential of species of the Acer L. genus the method of cluster analysis of wood plants was used (Table 3). Cluster analysis makes it possible to justify the objectivity of the assortment selection of woody plants for creation of garden and park plantations on the similarity of the manifestation of ornamental qualities (Semenyutina, 2014).

Table 3. Cluster analysis criteria [8]

Clusters	Criteria
Agro-climatic factors of the towns of Rostov agglomeration	Average longstanding temperatures, precipitation amount per year , amount of effective temperatures per vegetative period, edaphic conditions
Taxation characteristics	age, height, trunk diameter, crown length, canopy closure, height of tree body, plant location, density, conservation
Plant adaptation	winter resistance, frost resistance, drought resistance, heat resistance, disease and pest resistance, viability, prospectivity
Plant ornamentation	Ornamental features (crown ornamentation, foliage colour, blossoming, fruit productivity, autumn foliage colouring)

Their usage in greenery plantations for public use is very promising (Figure 8).



*** var 1-8 - Acer platanoides L.; var 9-16 - Acer saccharinum L.; var 7-24 - Acer pseudoplatanus L.**

Streets - var 1, 2, 9, 10, 17, 18
Square - var 3, 4, 5, 11, 12, 13, 19, 20, 21
Park - var 6, 7, 8, 14, 15, 16, 22, 23, 24
Alley - var 1, 3, 6, 9, 11, 14, 17, 19, 22
Massifs of trees var 5, 8, 13, 16, 21, 24
Wood groups - var 2, 4, 7, 10, 12, 15, 18, 20, 23

Figure 8. Prospects of application of species of the Acer L. genus on the objects of landscaping of Rostov region on the basis of cluster analysis

The durability of woody plants plays an important role in park and landscape architecture as mature and developed trees represent greater degree of ornamentation. The maples studied do not equally retain its basic ornamental feature as the crown shape when getting older. Bosnian maple and sycamore maple can preserve the natural shape of the crown in the absence of shading for up to 50-60 years and belong to the 1 group of ornamental durability (Table 4).

Table 4. Ornamental durability of species of the Acer L. genus according to the crown shape in different types of urban plantations of Rostov agglomeration

Species	Crown shape by Kolesnikov A.I. (1974)	Ornamental durability by our obresvations			Durability group*
		Parks	Public gardens	Street plantations	
Acer platanoides L.	widely orbicular	80±5	60±5	60±5	1
Acer pseudoplatanus L.	oval	50±5	50±5	50±5	1
Acer saccharinum L.	widely orbicular or oval	45±5	45±5	45±5	2

* determined by L. O. Pokhilko scale (2009)

Based on the literary sources studied and the research area, it is possible to recommend the use of species of the Acer L. genus in street row and alley plantings - Acer platanoides L.; A. platanoides 'Globosum', A. pseudoplatanus L., A. saccharinum L. (Table 5).

Table 5. Distribution of species of Acer L. genus by areas of application in Rostov region and by plantation types

Species	Recommended areas of application	Types of plantations			
		Groups	Alleys	Street plantations (avenues)	Woodlands
Acer platanoides L.	1, 2, 3,4, 5,6, 7, 8, 9	+	+	- (+)	+
Acer platanoides 'Globosum'	1, 2, 3,4, 5,6,7	-	+	+ (+)	-
Acer platanoides L. (ornamental forms)	1,2,3,4, 5,6,7	+	-	-	-
Acer pseudoplatanus L.	1,2,3,4, 5,8,9	+	+	+ (+)	-
Acer saccharinum L.	1,2,3,4, 5,6,7,8, 9	+	+	+ (-)	-

* 1 –Rostov-on-Don; 2 –Bataisk; 3 –Aksai; 4 –Novocherkassk; 5 –Shakhty; 6 –Azov; 7 –Taganrog; 8 – Chaltyr; 9 – Starocherkasskaya

All of the presented species of the Acer L. genus are valued as ornamental trees in park and landscape architecture, for single planting in parks and on boulevards, in woodlands, as well as for the creation of shady alleys that is one of the fundamental principles in landscaping of the arid region.

Conclusions:

1. It has been found out that the area of greenery plantations of Rostov agglomeration tends to decrease and the area of urban territory and population has increased by 7.8 and 3.3 times respectively since 1980. Functioning of greenery plantations is restricted by the age structure of plantations. Among the public use areas the provision per 1 resident is 16 m2 (planned standard for agglomeration is 36 m2).

2. It has been discovered that the area of public greenery plantations with participation of representatives of the Acer L. genus in Rostov region is 11.42 hectares (about 27.5 thousand trees). Among them 62.46% (Rostov-on-Don) and 70.15% (Novocherkassk) are between 51 and 80 years old. A. saccharinum L. predominates in street plantations, its age limit is 50 years old. The participation share of Acer platanoides L. varies between 8.1-10.2, A. pseudoplcitcinus L. 3.0-4.4, A. saccharinum L. 0.4-1.7, A. platanoides "Globosum" 1.1-5.4%.

3. The plantations are dominated by Acer platanoides L. at the age of 50-60 years old. The state of trees depends on the age. The best state of trees under the current cultivation conditions is observed at the age under 50 years old, later there are degradation processes due to species and age related categories.

4. The Acer L. species studied differ from each other in seasonal growth rhythm. The distribution regularities of phenological dates are characterized by a high density degree and involve the sum of effective temperatures.

5. The nature of luminosity under the maple plantations canopy affects the density of the lawn covering. The minimum value ensuring preservation of ornamentation is 6978.1 lx. The change in luminosity under the A. platanoides L. canopy is described by the regression equation $y = 2642.95x\ 1928.8$ ($R^2 = 0.999$).

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