Introduced Trees in Park-monument of Landscape Art in Poltava City

Elisaveta Grybovich[1], Olena Khalymon[2], Svitlana Los*[3]

[1]Kharkiv National Agrarian University named after V.V. Dokuchaev
P.O. Dokuchaevske-2, Kharkiv distr., Kharkiv reg., 62482, Ukraine
E-mail elizaveta.gribovich@ukr.net
[2] The Poltava Museum of Local Lore named after Vasyl Krichevsky
2, Konstitutsia Street, Poltava, 36020, Ukraine. E-mail khalymon@ukr.net
[3]Ukrainian research institute of forestry and forest melioration
named after G.M. Vysotsky (URIFFM)
86, Pushkinska str., Kharkiv, 61024, Ukraine. E-mail svitlana_los@ukr.net

(Received in January, 2018; Accepted in April, 2018; Available Online from 8th of May, 2018)

Abstract

The history of establishment of four park-monuments of landscape art in Poltava city – Korpusnyj Garden, Petrovsky Park, Poltava City Park, Park "Peremoga" were revealed and the dynamics of their species composition was outlined. The results of 19 non-native tree species researches in four parks of Poltava city are presented. Indicators of growth rate and reproduction intensity, stem quality, resistance to climatic factors, pests and diseases of non-native tree species are compared to native species. According to the results of the complex evaluations, the species are suitable for forest plantation, protective stands and green areas creation in temperate continental climate of Ukraine conditions.

***Key words**: introduction, specie, park-monument of landscape art, sustainability, growth, selection category, reproduction, complex estimation.*

Аннотация

Изложена история создания четырех парков памятников садово-паркового искусства города Полтавы – Корпусного сада, Петровского парка, Полтавского городского парка, парка «Победа» и проанализирована динамика их видового состава. Приведены результаты исследований, 19 видов интродуцированных древесных растений в этих парках. Представлены показатели интенсивности роста и репродукции, качества стволов, устойчивости к климатическим факторам, вредителей и болезней интродуцированных видов по сравнению с показателями аборигенных видов. По результатам комплексной оценки определены виды, перспективны для создания лесных, защитных насаждений и озеленения в условиях умеренного континентального климата Украины.

***Ключевые слова**:* интродукция, вид, парки-памятники садово-паркового искусства, устойчивость, рост, селекционная категория, репродукция, комплексная оценка.

Introduction

Poltava city is the regional centre of the Poltava region and one of the industrial and cultural centres of the Left Bank Forest-steppe of Ukraine. It is located on the banks of the Vorskla river on the territory of the East European Plain. The climate of the regional centre has temperate continental features. Average air temperature in July is + 20.5 °C; the average temperature in January is – 7.0 °C; annual rainfall – 525 mm; coefficient of humidification – 0.7. The frosty period duration is 174 days (Географічні відомості…).

Poltava is one of the most landscaped Ukrainian cities, its green area occupies about 30.5 % of the total area (2543 hectares, including 939 hectares belonging to public places). There are 23 parks in the city with a total area of about 255 hectares, 28 parks, 12 boulevards and 6 green areas. The green ring of suburban forests of 40 thousand hectares surrounds the regional centre. Parks are a place of the population recreation, an object of historical and cultural value, scientific research, educational work. The eight parks of Poltava city have the status of park-monument of landscape art: Poltava City Park – of national importance, the rest (Korpusny Garden, Petrovsky Park, Park "Peremoga", park named after I.P. Kotlyarevsky, park on the farmstead of Panas Mirny, parks of Agrarian-economic College and Agrobiostation Pedagogical University) – local. Some of them are

* Kontaktinis asmuo / Corresponding author

examples of landscape architecture of the beginning of the XIX century, others – the beginning of the XX century (Панасенко, 2005; Байрак, Самородов, Панасенко, 2007).

Dendroflora of the Poltava parks are investigated: S. Ilyichevsky (1927)], F. Berglezov (1928), O.Bayrak, V.Samorodov, T. Panasenko (2007), O. Khalymon (2002, 2004, 2009, 2012). But it should be noted, however, that the study of planting in park-monument of landscape art in the North-Poltava Highland region is still episodic and applies only to some of them (Байрак, 2012; Байрак, Самородов, Панасенко, 2007; Панасенко, 2005; Халимон, 2004; Байрак., Яценко, Халимон, 2002; Халимон, 2009; Халимон, 2012). The studying of the peculiarities of the growth and adaptation of introduced trees in park-monument of landscape art, the determination of perspective species for the forest plantations and gardening remains actual.

The aim of this work was to determine the non-native trees species suitable for practical use in different target values stands based on the results of a complex evaluation of growth, development and sustainability indicators, of woody plants, presented in the park-monument of landscape art of Poltava.

Methods

The trees of species, which, according to preliminary data, suitable for planting of different target values stands were investigated in the parks. The height, diameter at 1.3 m, selection category, sustainability, reproduction intensity was determined for each of 5–20 trees of each species. As a control were used the most taxonomically similar native species or aboriginal species traditionally grown in the region in such conditions («Рекомендації…», 2008) of the same age, which are represented in the same parks or the tabular data for *Quercus robur* L («Нормативно…», 1987). The age of trees was determined from archival materials regarding the time of their planting.

In determining the sustainability of non-native trees, the following indicators were evaluated: winter and drought resistance, degree of damage by insects and disease, abundance of fruiting (Былов, 1978; «Методика…», 2014) with specifications.

Estimation of winter resistance was carried out according to a modified method based on the "Methodology for the Examination of Varieties..." («Методика…», 2014): 5 points – plants are not damaged. Vegetation begins with apical buds; 4 points – frosted or faded apical, partially lateral, kidneys, insignificant frosts of tops of shoots last year, weak darkening of the wood, light brown coloration, bark has slight damage; 3 points – extinct completely shoots of last year and older shoots partially damaged; 2 points – severe damage to the whole plant. Condition of the plant is close to death; 1 point – very severe damage to the crown and corn plants causing the death of the plant.

Resistance to drought was estimated on the following scale: 5 – plants do not react to drought: even in daylight hours there is a normal turgor leaves and shoots; 4 – there is a loss of turgor: the edges of the leaves are lowered to the bottom, leafy leaves are wrinkled, young shoots are fluffy, with lowered tops; 3 – in most leaves there is partial damage: leaf blades have changed the color; 2 – most leaves have dried up, young shoots have dried up in part; 1 – the plant died («Методика…», 2014).

To determine the resistance of woody plants to leaves or needles damage by pests, we used the following scale: 5 – no damage; 4 – slight defeat: afflicted single tops and up to 25 % of the leaf area (needles) (mostly on the shoots of the current year); 3 – average lesion: up to 50 % of the surface of the leaves (needles) is affected; 2 – significant defeat: over 50 % of the leaves (needles) are affected; 1 – defeat over 75 % of leaves (needles).

The plant resistance to disease by pathogens was assessed by the following points: 5 – no damage; 4 – slight defeat: afflicted single tops and up to 25 % of the leaf area (needles) (mostly on the shoots of the current year); 3 – average defeat: up to 50 % of the surface of the leaves (needles)

* Kontaktinis asmuo / Corresponding author

is affected; 2 – significant defeat: over 50 % of the leaves (needles) are affected; 1 – defeat over 75 % of leaves (needles) («Методика…», 2014).

The mean stability score is defined as the mean arithmetic of the indexes of frost resistance, drought resistance, resistance to damage by pests and disease.

The fruiting intensity was evaluated by the scale of A. Kalinichenko (Калініченко, 1978).

The complex evaluation of growth rates, stability and stem quality, based on N. Vysotskaya (Висоцька, 2010) and S. Los with co-authors (Лось, Нейко, и др., 2012) with specifications (Table 1). The evaluations of the tree stem quality based on the proportion of trees of the I and II selection categories, which were determined on the modified scale of M. Veresin (Волосянчук Р., Лось С., Торосова Л., 2003).

Table 1. Scale of species complex evaluation

Point	Height-Growth Rates	Diameter-Growth Rates	Stem quality	The average point is sustaina-bility	Fruiting intensity
1.	Slowly growing (lagging behind controls by 10.1 % or more)	Slowly growing (lagging behind controls by 30.1 % or more)	The trees of the I – II selection categories are absent	1,0–1,4	Single fruits or cones
2.	Relative slowly growing (behind the control by 4.0–10.0 %)	Relative slowly growing (behind the control by 10.0–30.0 %)	The share of trees of the I – II selection categories is 1.0 – 10.0 %	1,5–2,4	Weak fruiting
3.	Middle growing (at the control level or difference up to 4.0 %)	Middle growing (at the control level or difference up to 10.0 %)	The share of trees of the I – II selection categories is 10.1 –15.0 %	2,5–3,4	Middle fruiting
4.	Relative fast growing (dominated control by 4.0–10.0 %)	Relative fast growing (dominated control by 10.0–30.0 %)	The share of trees of the I – II selection categories is 15.0 – 20.0 %	3,5–4,4	Good fruiting
5.	Fast growing (dominated control by 10,1 % and over)	Fast growing (dominated control by 30,1 % and over)	The share of trees of the I – II selection categories is 20.1 % or more	4,5–5,0	Abundant fruit bearing

The result of complex evaluation of species was based on the sum of points determined by their average quantitative and qualitative indexes, that is: 1) unsuitable (5.0–11.5 points); 2) suitable for the protection stands and the green area creation (11.6–18.5 points); 3) suitable for the forest plantation, the protective stands and the green area creation (18.6–25 points).

As the objects of research were selected 4 park-monuments of landscape art of the city of Poltava, which represent the largest number of non-native species (Korpusny Garden, Petrovsky Park, Poltava City Park, Park “Peremoga”).

Results and Discussion

The official date of the opening of the **Korpusny Garden** is 27 June 1909 (the date of celebration of the 200th anniversary of the Poltava Battle). But planting work at the Round Square, which is now occupied by the park, was carried out from the 30's of the XIX century, the entire ones were carried out from 1886. The area of the Korpusny Garden is 6 hectares, the style is regular. The species composition includes now about 50 species among them: *Tilia europaea* L., *Sorbus intermedia* (Ehrh.) Pers., *Aesculus hippocastanum* L, *Acer pseudoplatanus* L., *Quercus borealis* Michx. F., *Quercus robur* L., *Carpinus betulus* L., *Picea abies* (L.) Karst., *Picea pungens* L., *Picea orientalis* (L.) Peterm., *Pinus sylvestris* L., *Juniperus communis* L., *Juniperus sabina* L., *Mahonia aquifolium* Nutt., *Buxus sempervirens* L., *Spiraea* L. and others (Fig.1).

* Kontaktinis asmuo / Corresponding author


a

b

Fig. 1. Parter part of Korpusny Garden (A), Linden trees in Korpusny Garden (B) (photo by O. Khalymon, 2017)

The Linden trees of 130-years old, which have survived since the first plantings were observed in the park in 2017. The non-native species *Tilia europaea* L. showed a predominantly appearance of native *Tilia cordata* Mill. In the growth rates (Table 2). The stability and reproduction intensity of both species were at the same level (Fig. 3).

Table 2. Growth indices of tree species of surveyed parks

Species	Age, years	Average diameter, cm	Average height, m	Medium tree stem volume, m^3
1	*2*	*3*	*4*	*5*
Korpusny Garden				
Tilia europaea L.	130	50,9	22,5	2,13
Tilia cordata Mill.	130	47,7	19,6	1,66
Petrovsky Park				
Ulmus carpinifolia Rupr.	110	67,9	26,6	4,24
Tilia europaea L.	110	60,4	22,0	2,93
Sorbus intermedia Ehrh.	110	51,9	13,5	1,11
Quercus robur L. (tabl. «Нормативно…», 1978)	110	45,5	29,6	2,26
Poltava City Park				
Salix alba L.	55	42,8	14,4	1,02
Sorbus torminalis L.	55	19,9	13,7	0,20
Phellodendron amurense Rupr.	55	20,1	9,6	0,14
Juglans cinérea L.	55	23,0	12,7	0,26
Juglans nigra L.	55	26,6	12,7	0,34
Juglans mandshurica Maxim.	55	24,8	16	0,36
Larix sibirica Ledeb.	55	24,6	16,5	0,40
Platanus occidentalis L.	55	19,7	11,3	0,17
Pinus banksiana Lamb.	55	22,7	6,0	0,16
Populus simonii Carr.	55	52,4	18,4	1,89
Populus ‘Tronko’	55	47,5	19,0	1,62
Populus nigra var. *pyramidalis* Spach.	55	35,7	19,4	0,93
Quercus robur L. (tabl. «Нормативно…», 1978)	55	24,2	21,0	0,38
Park “Peremoga”				
Juglans cinérea L.	40	35,8	21,3	0,88
Juglans nigra L.	40	33,5	24,0	0,91
Quercus rubra L.	40	38,8	25,3	1,43

* Kontaktinis asmuo / Corresponding author

Table 2 continued

1	*2*	*3*	*4*	*5*
Sorbus intermedia Ehrh.	40	51,9	13,5	1,11
Acer saccharinum (Carr.)	40	45,2	25,8	1,60
Acer pseudoplatanus L.	40	45,0	22,5	1,61
Larix sibirica Ledeb.	40	25,6	18,2	0,46
Populus nigra var. *pyramidalis* Spach.	40	67,6	27,3	4,90
Tilia europaea L.	40	61,1	21,0	2,78
Quercus robur L.	40	56,3	22,8	2,61

Petrovsky Park, opened in 1909 to the 200th anniversary of the Poltava Battle occupies an area of 2 ha created in regular style. Species composition has 57 species, forms and hybrids. About 15 species and forms have been observed since the first plantings to the present day, in particular: *Aesculus hippocastanum* L., *Ulmus caprinifolia* L., *Sorbus intermedia* Ehrh., *Tilia europaea* L. and *Tilia heterophylla* Vent., *Quercus robur* L. and *Quercus robur f. fastigiata* (Lam.) DC., *Acer platanoides* L. (Халимон, 2009) (Fig. 2.).

a **b**

Fig. 2. Petrovsky Park. View to The Poltava Museum of Local Lore named after Vasyl Krichevsky (A), 130 years old tree of *Ulmus carpinifolia* Rupr (B) (photo by O. Khalymon 2017)

In the park in 2017, the trees of *Tilia europaea* L., *Ulmus carpinifolia* Rupr and *Sorbus intermedia* Ehrh. 110 years old that have been survived since the first plantings were investigated. All observed species are dominated by tabular indices of *Quercus robur* L. by diameter, but lag behind by height (Table 1). Only *Sorbus intermedia* (Ehrh.) Pers is behind by the average tree stem volume. All these species have relatively high resistance to biotic and abiotic factors (Fig. 3).

The largest park of the Poltava region is the **Poltava City Park**, created in 1962 on area of 124.5 ha, in the landscape style. Its territory includes 18 ha of natural oak forest with a predominance of 130–140-year-old oaks, the so-called Yakivchansky forest. The species composition of Poltava City Park dendroflora has about 200 species and forms. The family *Rosaceae* Juss., *Salicaceae* Mirb., *Pinaceae* Lindl., *Oleaceae* Hoffmanns & Link and *Caprifoliaceae* Juss. are represented in the collection most fully (Халимон, 2009, 2012).

11 non-native tree species observed in 2017 were conditionally divided into three groups. The first one it is a fast-growing species (*Salix alba* L., the *Populus simonii* Carr., The *Populus nigra* var. *pyramidalis* Spach.), which at slightly lower height are almost twice exceed the table index of *Quercus robur* L. by the diameter and three times by stem volume. *Juglans nigra* L., *Juglans mandshurica* Maxim. and *Larix sibirica* Ledeb. characterised by close indexes of diameter and stem volume at lower height. Third group of trees – *Sorbus torminalis* L. *Phellodendron amurense* Rupr.

* Kontaktinis asmuo / Corresponding author

Juglans cinerea L. *Platanus occidentalis* L. *Pinus banksiana* Lamb. lags behind in growth of Quercus robur L. All listed species showed relatively high resistance to biotic and abiotic factors (Fig. 3).

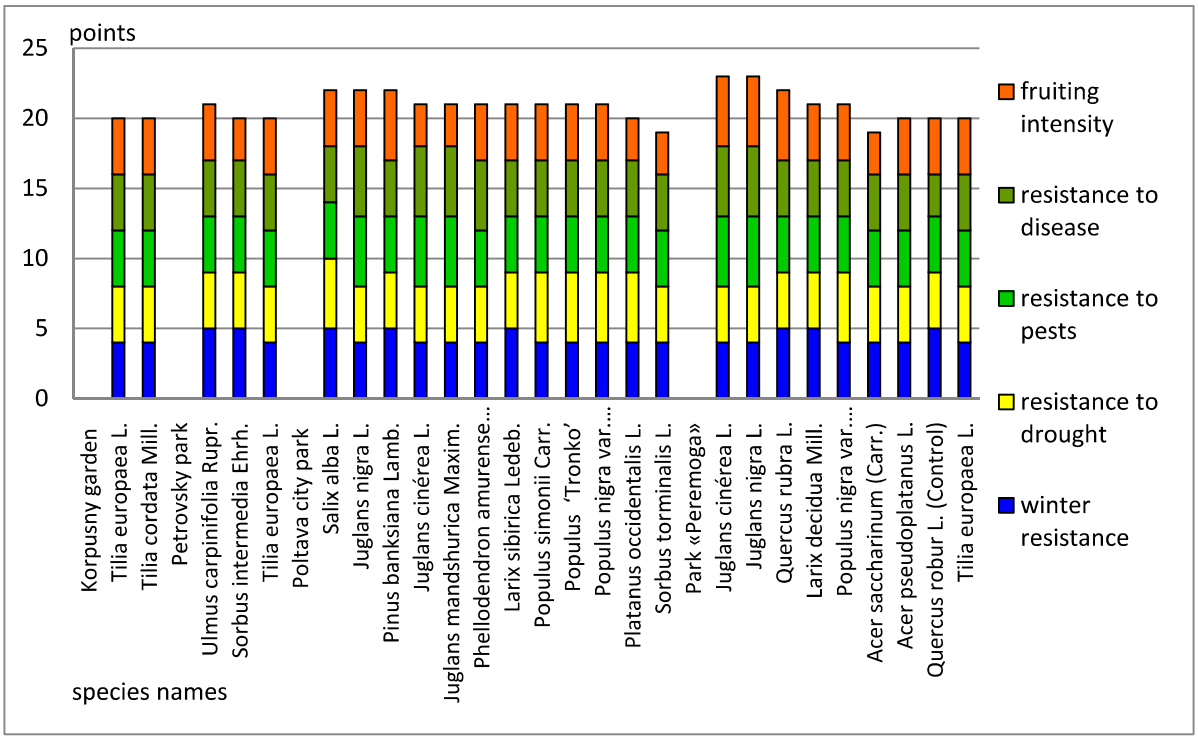

Fig.3. Estimation of sustainability of non-native species in Poltava parks

Park "Peremoga" (former Poltava City Garden) is the oldest park in the Poltava city. It was created in 1803 in place of the natural oak forest, belonging to the landowner S. M. Kochubei in landscape style. The park was strongly damaged in the years of the Second World War and in 1944–1945 it was reconstructed. Very few trees have survived from the first planting, in particular: *Quercus robur* L., *Acer pseudoplatanus* L., *Tilia europaea* L. and *Tilia cordata* Mill. Marousya Churai singing field, attractions, children's playground were built in the park. Now it is a favourite place for Poltava residents. In 1980, the second stage of the park was planted. Landing is made in the form of curtains. Among the non-native plants are planted: *Quercus rubra* L., *Juglans cinerea* L., *Juglans nigra* L., *Juglans mandshurica* Maxim, *Juglans regia* L., *Forsythia suspense* (Thunb.) Vahl., *Prunus divaricata* Ledeb., *Laburnum anagyroides* Medik., *Larix sibirica* Ledeb. Now the area of the "Peremoga" park is 47 hectares. Species composition has about 70 species.

In this park, in 2017, 8 non-native species and *Quercus robur* L. were observed. As in the previous park, it significantly exceeded the *Quercus robur* L. *Populus nigra* Spach. and was characterized by twice the stem volume (Table 1). The remaining species were distinguished by a slightly smaller diameter and stem volume. The average height higher than that of *Quercus robur* L. has *Juglans nigra* L. and *Quercus rubra* L. The stability of all non-native species was at *Quercus robur* L. level and higher (Fig. 3).

Summarizing the obtained data it should be noted that the highest resistance to frost and drought at the same time is noted only in *Salix alba* L. The highest winter resistance (5 points), in addition to the native species of *Quercus robur* L., was characterized *Ulmus carpinifolia* Rupr., *Sorbus intermedia* Ehrh. *Salix alba* L., *Quercus rubra* L. and *Larix sibirica* Ledeb. High drought resistance (5 points) was noted in *Salix alba* L., *Platanus occidentalis* L., *Populus simonii* Carr., *Populus* 'Tronko' and *Populus nigra var.* pyramid Spach which even exceeds the *Quercus robur* L. (4 points) indicator.

* Kontaktinis asmuo / Corresponding author

According to the proportion of trees of the I and II selection categories *Larix sibirica* Ledeb. and *Quercus rubra* L., *Ulmus carpinifolia* Rupr., *Juglans nigra* L., *Sorbus intermedia* Ehrh., *Acer saccharinum* (Carr.) were the best among the aboriginal species, *Quercus robur* L. was distinguished by the high stem quality, unlike *Tilia cordata* Mill., whose trees were mainly of curved stem (Fig. 2).

All non-native species trees in the parks have the signs of reproduction. The most intense fruiting was noted for *Pinus banksiana* Lamb. in the Poltava City Park, for *Quercus rubra* L., *Juglans nigra* L., *Juglans cinerea* L. in the park "Peremoga" (Fig. 4).

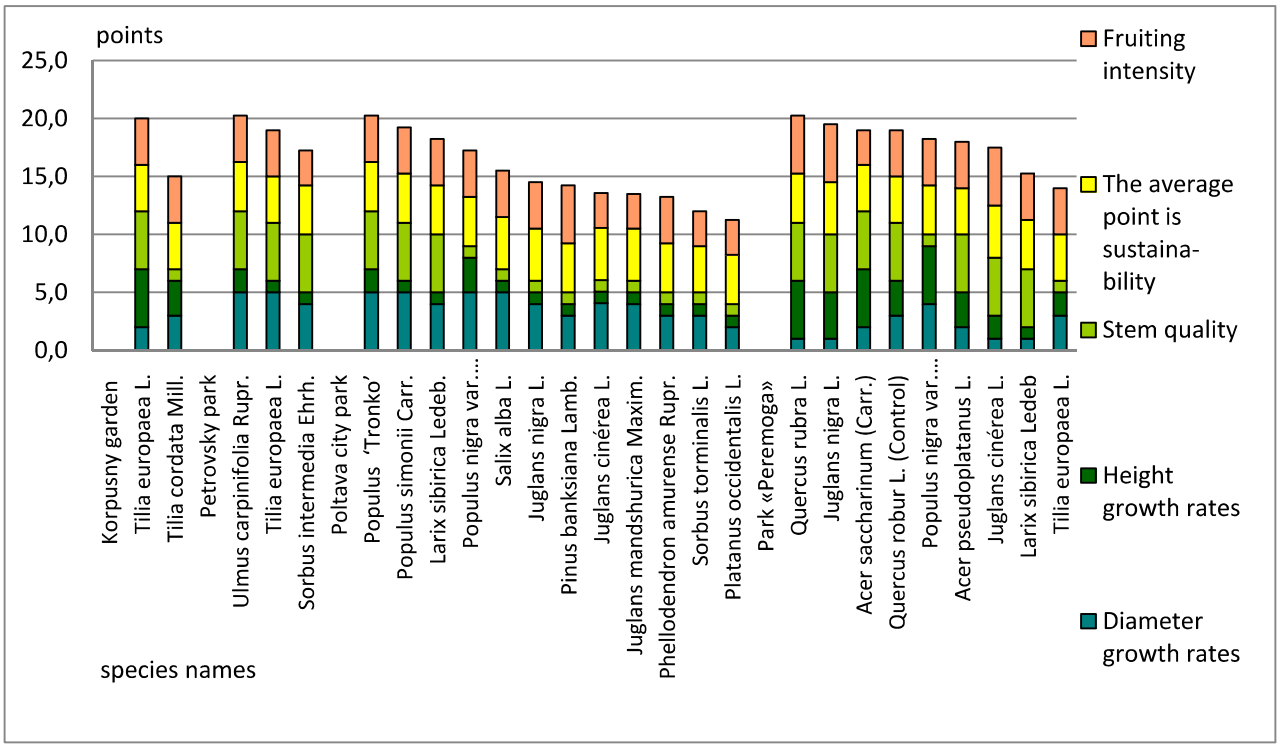

Fig. 4. Complex evaluation of non-native tree species in Poltava parks

According to the results of the integrated assessment, any of the species was not scored the maximum sum of points. About a third of the observed species belongs to the group species suitable for the forest plantation, the protective stands and the green area creation: *Tilia europaea* L., *Ulmus carpinifolia* Rupr., *Populus* 'Tronko', *Populus simonii* Carr., *Quercus rubra* L., *Acer saccharinum* (Carr.) and *Juglans nigra* L. Only one species (*Platanus occidentalis* L.) are included in the group of unsuitable species. The rest of the species was included in the groups suitable for the protection stands and the green area creation.

Conclusions

1. Among the 19 non-native tree species observed in 4 park-monuments of landscape art in of temperate-continental climate conditions, 7 species were suitable for the forest plantation, the protective stands and the green area creation: *Tilia europaea* L., *Ulmus carpinifolia* Rupr., *Populus* 'Tronko', *Populus simonii* Carr., *Quercus rubra* L., *Acer saccharinum* (Carr.) and *Juglans nigra* L. Among them *Populus* 'Tronko' and *Populus simonii* Carr. can be used to create forest plantation with a short turning cut for biomass and technical raw materials.
2. There were 9 species suitable for the protection stands and the green area creation in temperate continental climate conditions: *Sorbus intermedia* Ehrh., *Populus nigra* var. *pyramidalis* Spach., *Acer pseudoplatanus* L., *Juglans cinerea* L., *Larix sibirica* Ledeb., *Salix*

* Kontaktinis asmuo / Corresponding author

alba L., *Pinus banksiana* Lamb., *Juglans mandshurica* Maxim, *Phellodendron amurense* Rupr., *Sorbus torminalis* L.

3. Only one species (*Platanus occidentalis* L.) is included in the group of unsuitable species.
4. In the Poltava city parks the most of the non-native tree species well adapted to the temperate-continental climate conditions, form fruit and seeds in sufficient quantities and can be propagated by seed, while willow and poplar – vegetatively.

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* Kontaktinis asmuo / Corresponding author

Интродуценты в парках-памятниках садово-паркового искусства в Полтаве

(Получено в январе 2018 г.; отдано в печать в апреле 2018 г.; доступ в интернете с 8 мая 2018 г.)

Резюме

Изложена история создания четырех парков памятников садово-паркового искусства города Полтавы – Корпусного сада, Петровского парка, Полтавского городского парка, парка «Победа» и проанализирована динамика их видового состава.

Для комплексной оценки перспективности видов использованы балльные оценки интенсивности роста, устойчивости и качества стволов на частях деревьев I и II селекционных категорий. При определении устойчивости интродуцированных растений оценивали: зимостойкость, засухоустойчивость, степень повреждения насекомыми и поражения болезнями.

Среди 19 видов интродуцированных деревьев, обследованных в 4 парках-памятниках садово-паркового искусства в условиях умеренно-континентального климата, 7 видов оказались перспективными для создания лесных культур, защитных насаждений и озеленения: *Tilia europaea* L., *Ulmus carpinifolia* Rupr., *Populus* ‘Tronko’, *Populus simonii* Carr., *Quercus rubra* L., *Acer saccharinum* (Carr.) и *Juglans nigra* L. Среди них *Populus* ‘Tronko’ и *Populus simonii* Carr. могут быть использованы для создания плантационных культур с коротким оборотом рубки для получения биомассы и техсырья.

Перспективными для создания защитных насаждений и озеленения в условиях умеренно-континентального климата оказались 9 видов*: Sorbus intermedia* Ehrh., *Populus nigra* var. *pyramidalis* Spach., *Acer pseudoplatanus* L., *Juglans cinerea* L., *Larix sibirica*, Ledeb *Salix alba* L. *Pinus banksiana* Lamb., *Juglans mandshurica* Maxim., *Phellodendron amurense* Rupr. и *Sorbus torminalis* L.

В группу неперспективных видов включен только один вид (*Platanus occidentalis* L.).

В парках города Полтавы большинство интродуцированных древесных видов хорошо адаптировались к условиям умеренно-континентального климата, образуют плоды и семена в достаточном количестве и могут быть размножены семенным путем, а ивы и тополя - вегетативно.

* Kontaktinis asmuo / Corresponding author