

**THE STRUCTURE OF POPLAR TREES IN URBAN  
GREEN AREAS OF NOVI SAD**

**Sinisa Andrasev<sup>1</sup>, M. Bobinac<sup>2</sup>, S. Roncevic<sup>1</sup>, M. Vuckovic<sup>2</sup>, B. Stajic<sup>2</sup>**

<sup>1</sup>University of Novi Sad, Institute of Lowland Forestry and Environment,  
Antona Cehova 13d, Novi Sad, SERBIA

<sup>2</sup>University of Belgrade, Faculty of Forestry, Kneza Visislava 1, Belgrade, SERBIA

**ABSTRACT**

Researches were conducted in the urban area of Novi Sad, in parts of city where poplar trees are found. Each poplar tree was measured the breast height diameter, total height and was assessed damage in the crown and lower part of the trunk. In addition each tree was determined age category. Elements of growth show that poplar trees showing good size, which confirms that they are on their habitat and to have favorable conditions for growth in urban conditions. Age structure of trees shows that the poplar used in the establishment of public green areas in different long period which is mostly coincides with the urbanization of certain areas of the city.

**Key words:** poplar trees, structure of trees, urban green spaces, Novi Sad.

**INTRODUCTION**

Novi Sad is located on the alluvial plain of the Danube, whose zone of influence in the formation alluvial soils and soil water regimes in the city is very pronounced. This is the reason that in this area poplar and willow, as a native species, used in the greening of the city. Since the formation of the city in the end of the seventeenth century, the green areas were being formed, which are by the purpose and style vary depending on the period in which they occur. The use of poplar and willow in greening the city center had not a wider character, due to the poplar in the greening of urban settlements and the raising of parks on the outskirts were on periphery of the interests of horticultural experts because of their modest decorative features, short-liveness, brittleness of wood and an increased incidence of windbreak, and in the present classification of pollen trees and seed allergens [1]. Also, the greening of cities were frequent failures due to insufficient knowledge of poplar planting technology.

Intensive urbanization in the wider area of Novi Sad after the World War II meant considerable changes in habitats and soil characteristics: because of the unequal terrain and low elevation, it was necessary to raise the terrain in order to prevent negative impact of the Danube on life of inhabitants, especially groundwater. The raise of the terrain on the "safe" elevation was done with sand from the bed of the Danube, in the thickness of 3-5 m, which is an unfavorable due to the technique of filling sand, where organic matter and clay particles is washed, and especially the inability to keep atmospheric water.

As a result of the development of poplar production the technique so called "deep planting" was defined where seedlings without root (pole) was planted to a depth of groundwater [2]. Deep planting technique was first applied 1969<sup>th</sup> years in setting up greenery in Novi Sad, establishing the complex of university park [3]. The results were excellent in technological and economic terms. As advantages of this method are: the minimum preparation of terrain, relatively inexpensive procedure of establishing (only 25% of the cost of establishing greenery in conventional manner) and maintenance of greenery, very great percent of plant survival and rapid growth of trees. Based on these advantages this method is applied to the establishment of greenery in the area of the whole city and, depending on soil characteristics, combined with the conventional method of establishment.

Poplar trees were planted in the alleys (line plantings), alone or in small or large groups in urban foreheads: streets, residential blocks, parks, factory circles, in addition to schools, kindergartens and so on. The basic purpose of poplar plantations was the humanization of urban areas and priority role of greenery was to meet more demands in a short time, above all to achieve its sanitary-hygienic role (the elimination of air pollution, improve the microclimate, noise reduction), and then reached aesthetic and visual effect.

In economically significant poplar plantations age of 30 years is considered to be so called "upper" age after which the cutting of trees and raising young plants is done. In urban conditions, poplar trees have much more space for growth, often trees have so called "solitary" growth, while the production function is not emphasized. Upper age is linked to the state of trees and the satisfaction of sanitary-hygienic and ornamental-aesthetic functions [4].

The aim of this study was to determine the structure and assess the state of poplar trees in urban green areas of Novi Sad, which will allow assessment of their sustainability and functionality. Special emphasis is put on the age structure of poplar trees, the elements of growth and degree of damage (health status).

## **OBJECT OF RESEARCH AND WORK METHOD**

Researches were conducted in the urban area of Novi Sad in two phases during 2011<sup>th</sup> year. In the first phase the spatial presence of poplar trees was recorded. In a second phase the collection of data were acceded which had the character of inventory: a presence of some poplar species, size and degree of damage (health status) were determined. At the inventory the principle of random and systematic sampling is applied. A systematic principle consisted in it that the location in the city with the poplar trees

were chosen (as in some parts of city poplar trees are not represented). After the spatial location of trees and tree groups applied the principle of random selection of locations from which to collect data. Then at each location trees were selected by systematic principle: to represent different categories of trees in terms of type, age, size and damage, while selected trees realistically displayed their participation in each location. In this respect the data were collected within 41 groups of trees in the city of Novi Sad (Figure 1).

Each tree was measured the breast height diameter by two cross measurements with an accuracy of 1 mm, and total height with the Vertex altimeter, with an accuracy of 0.1 m. Each tree was assessed damage in the form of the following evaluations: (1) the presence of individual dry branches in the crown (up to 10% of the crown) , (2) the presence of dry branches in the tree crown over 10%, (3) the presence of holes of xylophagy insects in the root swelling of trees, (4) the presence of decay in the root swelling of trees, and (5) the presence of mechanical injuries in the lower part of trees, which are caused by man.

In a number of trees wood samples were taken by Presler's borer at the breast height in order to determine the age category of trees. After drying the samples annual growth rings were counted in the laboratory.

In total there is measured, assessed and drilled 129 trees, within 66 trees were Lombardy poplar (*Populus nigra* var. *Italica*) and 63 trees were Hybrid poplar (*Populus* × *euramericana* Dode Guinier).

To define the significance of differences in the elements of growth (height and diameter at breast height), and the difference in age of trees, between Lombardy poplar (LP) and Hybrid poplar (HP), the t-test was used.

## RESULTS AND DISCUSSION

Studies have shown that the poplar trees located on the wider area of Novi Sad, from the riparian zone to the peripheral zone of the city, the furthest from the Danube River (Figure 1).



**Figure 1.** Location of assessed poplar trees in Novi Sad (Source: Google Earth).

Based on the inventory of poplar trees it was found that diameters of trees are in the range 21-97 cm for Lombardy poplar trees, and 17-97 cm for Hybrid poplar trees. Mean breast height diameter amount of 54.9 cm for Lombardy poplar and 57.7 cm for Hybrid poplar, which is not significantly different by t-test. Lombardy poplar trees had less variation in breast height diameter (22.4%) compared to the Hybrid poplar trees (31.8%) . (Table 1).

Lombardy poplar trees had a height of 15.1 to 35.6 m, and Hybrid poplar trees 10.5 to 36 m. Mean height of Lombardy poplar trees of 28.5 m was significantly higher ( $p < 0.001$ ) than the mean height of Hybrid poplar trees (25 m) by t-test (Table 1).

Diameter structure is unimodal in both species with the highest number of trees around the mean. In Lombardy poplar trees larger number are with diameters 45-65 cm, compared to Hybrid poplar trees, which are more numerous with diameters 75-90 cm (Figure 1a).

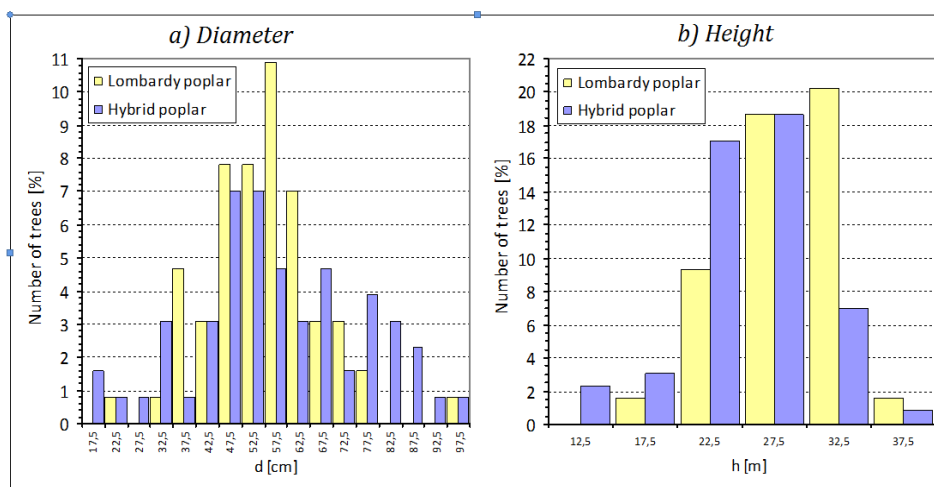
**Table 1.** The elements of growth and age of assessed poplar trees in Novi Sad.

	<i>d [cm]</i>				<i>h [m]</i>				Age [year]			
	average	cv%	min	max	average	cv%	min	max	average	cv%	min	max
LP*	54,9	22,4	21,0	97,2	28,5	14,8	15,1	35,6	42	15,9	25	52
HP	57,7	31,8	17,5	96,8	25,0	19,1	10,5	36,0	32	38,1	10	47
t-test	-1,03 <sup>ns</sup>				4,35 <sup>***</sup>				6,08 <sup>***</sup>			
p-value	0,3068				2,7·10 <sup>-5</sup>				0			

\* LP – Lombardy poplar; HP – Hybrid poplar.

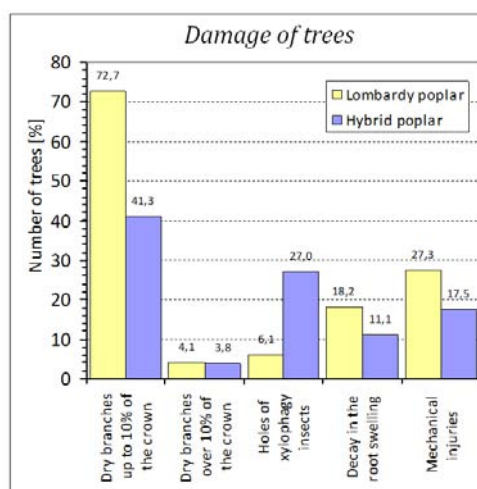
As with the diameter structure, height structure is unimodal with the largest number of trees that are located near the arithmetic mean. In the height degree of 25-30 m is an equal number of trees as Lombardy poplar and Hybrid poplar. In the height degree of 20-25 m number of Lombardy poplar trees is twice smaller than the Hybrid poplar, and in the height degree of 30-35 m was twice as high (Figure 1b).

Comparing the achieved breast height diameters and heights of poplar trees in the conditions of city of Novi Sad with the diameters and heights achieved in production plantations at the best habitats [5, 6] can be seen that they are in range, even higher than those in production plantations, while the heights are less. In urban conditions trees have much more space for growth, and growth can often be characterized as a "solitary", which caused more intensive diameter increment in relation to height [7].



**Figure 1.** Diameter and height structure

These diameters and heights of poplar trees, as Lombardy poplar and Hybrid poplar, indicating that they are on their habitat and to have favorable conditions for growth in the urban conditions of Novi Sad.



**Figure 2.** Damage to trees

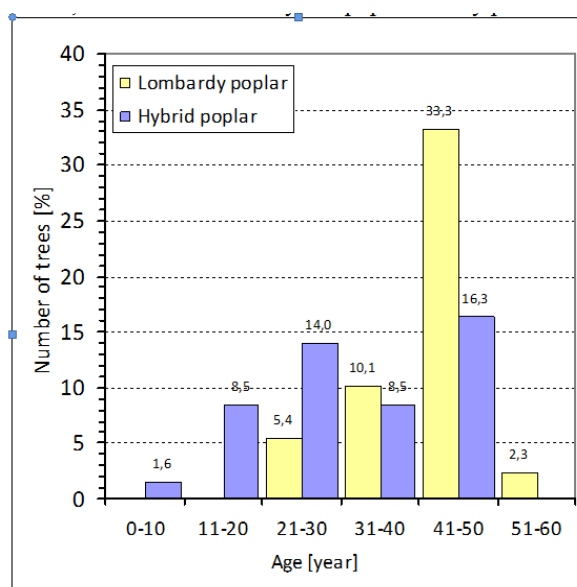
In both species, Lombardy poplar and Hybrid poplar trees, it was equally distributed (4%) trees with dry branches exceeding 10% of the crown, a single dry branches of the crown are found in 41% of the Hybrid poplar and over 70% of the Lombardy poplar trees. The presence of dry branches in the crown is the result of fungal

attack *Dothichiza populea* Sacc. et Br., and the lack of light needed for normal development of the foliage.

In the root swelling of the tree are determined the presence of holes of xylophagy insects with only 6% of the Lombardy poplar trees and in every fourth Hybrid poplar trees. The presence of decay in the root swelling was found in 18.2% of Lombardy poplar and in 11.1% of Hybrid poplar trees. The presence of mechanical injuries in the lower part of trees were found in 27.3% of Lombardy poplar and in 17.5% of Hybrid poplar trees (Figure 2).

Lombardy poplar trees had the age of 25 to 52 years, and Hybrid poplar tree from 10 to 47 years. The average age of Lombardy poplar trees was 42 years which is significantly higher ( $p < 0.001$ ) than the average age of Hybrid poplar trees of 32 years (Table 1). The coefficient of variation of age of Lombardy poplar trees is half of the Hybrid poplar trees. The majority, about 50% of all trees, is in the age group of 41-50 years. In this 2/3 of Lombardy poplar trees is aged 41-50 years, unlike the Hybrid poplar trees that are more evenly represented in the age categories from 11 to 50 years (Figure 3).

These data indicate that tree of Lombardy poplar significantly planted during the 1960's, while the trees of Hybrid poplar evenly planted in the last 50 years.



**Figure 3.** The age structure

Based on the analysis of participation of trees per age category and degree of damage can be concluded that the individual dry branches in the crown (up to 10% of the crown) present in trees older than 20 years, with the unclear influence of tree age on their participation. The trees of Hybrid poplar that are younger than 20 years do not have dry parts of the canopy (Table 2).

The presence of damage caused by xylophagous insect was found in Lombardy poplar in the age category of 41-50 years to about 10% of the trees. In the trees of Hybrid poplar the presence of damage caused by xylophagous insects is almost in all ages categories, and the share of damaged trees increases with age.

Decay of root swelling in the trunk of Lombardy poplar was found in the age category of 41-50 years, where every fourth tree had clear signs of damage. In trees of Hybrid poplar such damage occurs in the trees aged 21-50 years.

**Table 2.** Participation of the trees by age category and degree of damage.

Age category [year]	Number of tree		d <sub>1,3</sub>		h		Dry branches up to 10% of the crown		Dry branches over 10% of the crown		Holes of xylophagy insects		Decay in the root swelling		Mechanical injuries	
	[%]		[cm]		[m]		[%]		[%]		[%]		[%]		[%]	
	LP*	HP	LP	HP	LP	HP	LP	HP	LP	HP	LP	HP	LP	HP	LP	HP
1-10		3,2		20,8		11,40										
11-20		17,5		43,7		23,83						18,2				
21-30	10,6	28,6	47,9	55,3	24,84	24,78	71,4	61,1	8,6	1,1		22,2		11,1	14,3	22,2
31-40	19,7	17,5	54,5	72,0	24,94	24,48	53,9	27,3	5,0	4,5		27,3		9,1		18,2
41-50	65,2	33,3	55,2	63,1	30,25	27,46	79,1	57,1	3,4	8,1	9,3	38,1	27,9	19,1	39,5	23,8
51-60	4,5		68,0		26,90		66,7									

\* LP – Lombardy poplar; HP – Hybrid poplar

Mechanical injuries were detected in both studied species, mainly in trees over 20 years old.

With advanced age the trees have a larger diameter and height, but observed the anomalies that the oldest tree of Hybrid poplar have less breast height diameters than the trees aged 31-40 years, which can be associated with different microhabitat conditions, tree devitalization in particular age periods and their further slower growth due to the impact of these unfavorable factors.

## CONCLUSIONS

- The spatial representation of poplar trees in the wider area of Novi Sad, extends from the riparian zone to the the most distant peripheral zone of the Danube River.
- Age structure of trees shows that the poplar used in the establishment of public green areas in different long period which is mostly coincides with the urbanization of certain areas of the city, but there are exceptions, that the poplar trees from the previous period incorporated in the urban area and subsequently was entered.
- The average age of Lombardy poplar trees was 42 years, and of Hybrid poplar trees was 32 years, with 2/3 of Lombardy poplar trees aged 41-50 years, in contrast to Hybrid poplar of trees that are more evenly represented in the age categories from 11 to 50 years. This indicates that the Lombardy poplar trees,

planted significantly during the 1960s, while the trees of Hybrid poplar planted evenly in the last 50 years.

- Elements of growth show that poplar trees showing good size, which confirms that they are on their habitat and to have favorable conditions for growth in urban conditions.
- Health status and elements of growth by age categories shows that the older trees are of poor health, and can be correlated with age and longer exposure to urban conditions, which are manifested by mechanical injury (the man), dry branches in the crown, decay in root swelling (the disease), holes of the xylophagy insect in the root swelling of trees (the insects), and air pollution from traffic and industry.

## REFERENCES

1. Anastasijević N. (2007): Podizanje i negovanje zelenih površina. Univerzitet u Beogradu-Šumarski fakultet, Beograd
2. May, S., (1960): Jedan originalan način gajenja topole na peskovitim dinama u oblasti delte reke Po u Italiji. Topola, br. 13-14. Beograd. (2-10).
3. Milutinović, D., (1979): Topole i vrbe u ozelenjavanju Novog Sada. Savetovanje o stanju i mogućnostima razvoja topolarstva u Jugoslaviji. Institut za topolarstvo, Novi Sad, 8-9. septembra.
4. Anastasijević, N., Vučković, M., Vratuša, V., (1997): Funkcionalnost šumskog i ukrasnog drveća u gradskim zelenim površinama. Zbornik radova „EKO – Konferencija '97“, Ekološki pokret grada Novog Sada. 223-228.
5. Andrašev, S., Rončević, S., Vučković, M., Bobinac, M., Danilović, M., Janjatović, G. (2010): Elementi strukture i proizvodnost zasada klona I-214 (*Populus × euramericana* (Dode) Guinier) na aluvijumu reke Save. Glasnik Šumarskog fakulteta 101: 7-24. Beograd.
6. Marković, J., Rončević, S., Pudar, Z., (1997): Izbor razmaka sadnje pri osnivanju zasada topola. Topola, 159-160: 7-26. Beograd.
7. Stamenković, V., Vučković, M., (1988): Prirast i proizvodnost stabala i šumskih sastojina. Šumarski fakultet, Beograd. p. 368.