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THE GENETIC POTENTIAL OF MOTHER TREES AS A BASIS FOR *ACER PSEUDOPLATANUS* 'ATROPURPUREUM' PLANT PRODUCTION

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Abstract: Sycamore maple (*Acer pseudoplatanus* L.) is one of the most valuable species of Serbia's noble hardwoods. Based on the results of previous research, it can be concluded that this is a species with a pronounced ecological plasticity and high genetic potential. From the aspect of ornamentalness, one of the most frequent cultivars in urban green spaces and tree rows is the cv 'Atropurpureum', also known as 'Spaethii' or 'Purpureum'. It is distinguished by dark green leaf adaxials and purple undersides, which give the crown an extraordinarily attractive appearance.

The genetic potential of the analyzed mother trees can be used for the mass production of the *Acer pseudoplatanus* 'Atropurpureum' and *Acer pseudoplatanus* plants needed for urban green area maintenance and creation of tree rows. Special attention should be paid to the potential of mother trees 5 and 3; their descendants, along with purple leaf undersides, also have high average height values for five-year old plants.

Key words: Phenotypical expression, *Magnoliophyta*, selection, variability, urban habitat

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INTRODUCTION

The main directions for the reconstruction of the existing species and the creation of new cultivated forms (cultivars) consist of the detection and definition of the desired characteristics, selection of initial material, identification of qualitative and quantitative parameters, study of the methods of inheritance of the selected characteristics, and mass production of the improved planting material (Šijačić-Nikolić et al.. 2006).

Sycamore maple (*Acer pseudoplatanus* L.) is one of the most valuable species of Serbia's noble hardwoods. Based on the results of previous research (Fukarek, 1961; Gudeski, 1984; Tripić, 1988; Bojović, 1989; Ivetić and Tucović, 2003; Šijačić-Nikolić et al. 2006, 2009a), it can be concluded that this is a species with a pronounced ecological plasticity and high genetic potential, exemplified by a great number of cultivated forms: *Acer pseudoplatanus* 'Atropurpureum'; 'Brilliantissimum'; 'Variegatum'; 'Leopoldi'; 'Flavescens'; 'Flavo Variegatum'; 'Worleei' (Bojović, 1989). From the aspect of ornamentalness, one of the most frequent cultivars in urban green spaces and tree rows is 'Atropurpureum' also known as 'Spaethii' or 'Purpureum'. It is distinguished by dark green leaf adaxials and purple undersides, which give the crown an extraordinarily attractive appearance.

Based on numerous researches, it can be inferred that a substantial number of forest tree traits that are significant for breeding are determined by cytoplasmic structures. Of all the cytoplasmic organelles, the

best studied is the effect of plastids and mitochondria on phenotype characters. The role and effect of plastids in extra-chromosomal inheritance is successfully applied in the cultivar synthesis in floriculture, horticulture and forestry. The spontaneous occurrence of the green leaf color changes into violet, yellow or purple is the consequence of the presence of anthocyanin in the cell sap of epidermal cells, or of carotenoids in chromoplasts (Sarić et al. 1989). The pronounced phenotype attractiveness of such individuals has led to the synthesis of many of the cultivars used in the mass production of ornamental trees and shrubs.

MATERIAL AND METHODS

The genetic potential of ten *Acer pseudoplatanus* 'Atropurpureum' mother plants, selected in Belgrade's green areas, was evaluated at the half-sib family level. The development of the half-sibs, together with the phenotypical stability of the 'Atropurpureum' cultivar, has been continuously monitored during their juvenile phase of development (Šijačić-Nikolić et al. 2006, 2009a, 2009b, 2009c).

The seeds of the selected trees were planted during the fall (autumn) of 2005. Three months after germination the plants were brought outside. During the spring of the following year, when they were one year old, they were individually planted in plastic bags. They were planted outside (in the field) during the subsequent spring, i.e. when they were two years old.

In the fall of 2010 when they were five years old (Fig. 1), the variability of the plants' morphometric properties was subjected to analysis: height (cm) and diameter at the neck of the root (mm). The phenotypical expressions of purple, green and variegated leaf undersides were also analyzed for every half-sib line. The research covered seven half-sib lines because lines 1 and 6 had declined to a negligible numbers of individuals. In order to facilitate the statistical data processing, the plants with leaves with green undersides were marked 1, purple - 2, and variegated - 3. The research dealt with a sample of 30 individuals (10 individuals x 3 repeats) per every half-sib line. The collected data were processed using the «Statgraph 6.0» computer software. Cluster analysis was performed in order to determine genetic similarity, i.e. the distance between the analyzed half-sib lines, based on the data collected.

Fig. 1: Five-year old *Acer pseudoplatanus* 'Atropurpureum' plants, during field experiment (Ljig, September 2010)

RESULTS AND DISCUSSION

The summary statistics, analysis of variance and LSD test for morphometric properties of different half-sib lines of *Acer pseudoplatanus* 'Atropurpureum' plants are shown in Tables 1 and 2.

The results show that plants belonging to lines 3, 5 and 4 have the highest average height values. The lowest values are recorded for lines 8, 2 and 9. The recorded differences between the average height values of five-year old plants are statistically significant.

The average values for the diameter at the neck of the root vary from 21.59 mm (line 2) to 26.80 mm (line 3). The differences between the average values are statistically significant.

The phenotypical expression of purple, green and variegated leaf undersides in the analyzed half-sib lines can be determined through the data shown in Table 3. Green-colored undersides are marked 1

Table 1: Summary statistics, analysis of variance and LSD test for heights of half-sib lines of five-year old *Acer pseudoplatanus* 'Atropurpureum' plants

	Summary Statistics			
	Min	**Max**	**Average**	**Standard deviation**
2	88	280	163,67	50,44
3	100	302	219,66	47,73
4	115	281	199,46	42,53
5	108	292	202,43	50,95
7	115	250	174,10	36,62
8	84	251	150,03	46,71
9	110	261	169,67	36,42

Analysis of Variance

	Mean Square	F-Ratio	P-Value
Between mother trees	18551,3	9,22	0,0000

LSD test

	Average	Homogenuous Groups
8	150,03	X
2	163,67	XX
9	169,67	XX
7	174,10	X
4	199,46	X
5	202,43	X
3	219,67	X

Table 2: Summary statistics, analysis of variance and LSD test for diameters of half-sib lines of five-year old *Acer pseudoplatanus* "Atropurpureum" plants

	Summary Statistics			
	Min	**Max**	**Average**	**Standard deviation**
2	12,48	34,72	21,59	5,71
3	17,90	35,70	26,80	5,11
4	13,25	35,87	25,32	5,40
5	15,15	32,16	22,70	4,82
7	17,31	32,34	24,29	4,11
8	13,60	32,17	21,66	5,62
9	15,49	30,40	22,94	4,34

Analysis of Variance

	Mean Square	F-Ratio	P-Value
Between mother trees	113,94	4,45	0,0003

LSD test

	Average	Homogenuous Groups
2	21,59	X
8	21,65	X
5	22,70	XX
9	22,94	XXX
7	24,29	XXX
4	25,32	XX
3	26,80	X

and are characteristic of lines 9, 2, 7, 4. Purple undersides, one of the basic characteristics of the 'Atropurpureum' cultivar, marked 2, are present in lines 5, 8 and 3. Previous research at the level of one-, two- and three-year old plants shows that it is namely the mother trees 1, 3, 5 and 8 which produce a high percentage (80%) of descendants having leaves with purple undersides, continually (Šijačić-Nikolić et al. 2009a, 2009b, 2009c).

The results of the LSD test indicate the existence of two homogeneous groups. Plants bearing leaves with green undersides belong to the first group, and those with leaves with purple undersides – to the second. Plants having leaves with variegated undersides (marked 3) were recorded in lines 5, 7, and 8 (Fig. 2).

Cluster analysis (Diagram 1) is based on morphometric parameters and phenotypical expression of the color of the undersides in the analyzed half-sib lines.

The dendrogram shows the grouping of the lines in two homogeneous groups. One is comprised of lines 7 and 9 together with, at a distance, lines 2 and 8. The second group contains lines 4 and 5 joined by line 3. The differentiated half-sib lines clearly show the particular genetic potential of the mother trees; their descendants differ by analyzed characteristics.

Table 3: Summary statistics, analysis of variance and LSD test for leaf underside color of five-year old *Acer pseudoplatanus* 'Atropurpureum' plants belonging to different half-sib lines

	Min	Max	Average	Standard deviation
Summary Statistics				
2	1	2	1,30	0,46
3	1	2	1,86	0,34
4	1	2	1,43	0,50
5	1	3	2,03	0,41
7	1	3	1,40	0,72
8	1	3	1,90	0,71
9	1	2	1,20	0,41
Analysis of Variance				
	Between mother trees	Mean Square	F-Ratio	P-Value
		3,30	11,90	0,0000
LSD test				
		Average	Homogenuous Groups	
9		1,20	X	
2		1,30	X	
7		1,43	X	
4		1,43	X	
3		1,87	X	
8		1,90	X	
5		2,03	X	

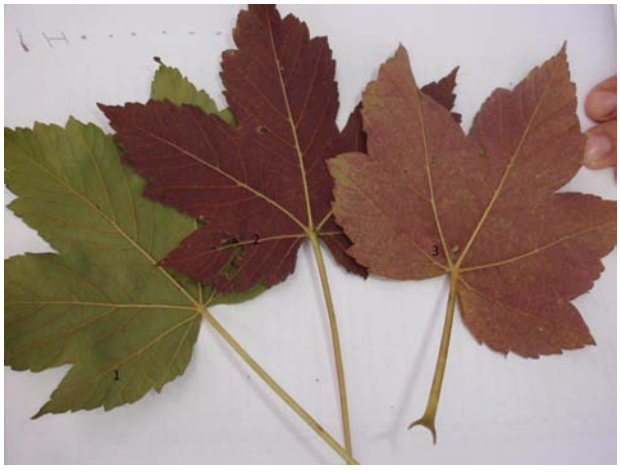

Fig. 2: Leaves of Sycamore maple plants with: green (1), purple (2) and variegated (3) undersides

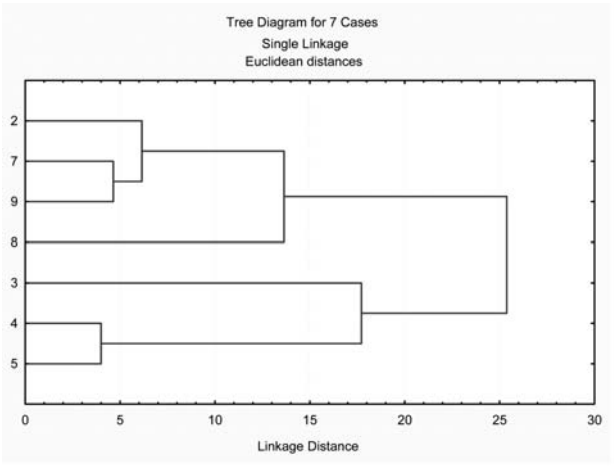

Diagram 1: Cluster analysis based on morphometric parameters and phenotypical expression of the color of the undersides in the analyzed half-sib lines of five-year old *Acer pseudoplatanus* 'Atropurpureum' plants

CONCLUSION

Based on numerous researches, it can be inferred that a substantial number of forest tree characteristics that are significant for breeding are determined by cytoplasmic structures. Of all the cytoplasmic organelles, the best studied is the effect of plastids and mitochondria on phenotype characteristics. The role and effect of plastids in extra-chromosomal inheritance is successfully applied in cultivar synthesis in floriculture, horticulture and forestry. The spontaneous occurrence of the green leaf color changes into violet, yellow or purple is the consequence of anthocyanin presence in the cell sap of the epidermal cells, or of carotenoid presence in the chromoplasts (Sarić et al. 1989). The pronounced phenotype attractiveness of such individuals has led to the synthesis of many of the cultivars used in the mass production of ornamental trees and shrubs.

The phenotypical expression of the leaf underside color in the 9 half-sib lines of *Acer pseudoplatanus* 'Atropurpureum' plants in their juvenile phase was continually monitored; the goal was to evaluate the genetic potential of the mother trees with purple leaf undersides as the basic selection criterion.

Starting from data from literature (Stilinović, 1987) that revealed that the seeds of the 'Atropurpureum' yield 50% individuals with purple leaf undersides and 50% with green leaf undersides, the goal of the present research was to select mother trees which would produce more offspring with leaves with purple undersides. Having in mind that experimental research so far shows that the color of the leaves is inherited mainly from the mother, this would create a good basis for 'Atropurpureum' plant production through generative propagation.

The results of the research which lasted for five years show the differentiation of the mother trees according to the prevailing leaf underside color (purple or green) of their respective descendants. Since the expression of purple leaf undersides is continual in lines 5, 8 and 3, while green undersides are characteristic of lines 9, 2, 7 and 4 during all five years of the research (Šijačić-Nikolić *et al.* 2006, 2009a, 2009b, 2009c), it can be concluded that the leaf underside color of the mother trees is genetically determined

The genetic potential of the analyzed mother trees can be used for the mass production of the *Acer pseudoplatanus* 'Atropurpureum' and *Acer pseudoplatanus* plants needed for urban green areas. Special attention should be paid to the potential of mother trees 5 and 3: their descendants, along with purple leaf undersides, also have high average height values for five-year old plants.

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