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Original Article

Variability of morphometric caracteristics of one-year seedlings of different half-sib European White Elm (*Ulmus effusa* Wild.) from the Great War Island

Jovana Devetaković, Mirjana Šijačić-Nikolić, Vladan Ivetić

Faculty of Forestry, University of Belgrade, Kneza Višeslava 1, 11000 Belgrade, Serbia

** E-mail: jovana2309@gmail.com*

***Abstract*:**
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European White Elm is recognized as a rare and endangered species in the forest fund of the Republic of Serbia. During the past century massive drying of elms occurred and the indications of their extinction appeared, which consequently led to a reduction in genetic diversity and the danger of genetic drift. In the area of the Great War Island near Belgrade we found 56 trees of European White Elm that are spatially divided into three subpopulations. In order to assess the genetic potential of European White Elm in the Great War Island and to define adequate conservation measures variability of 14 selected test trees progeny was rated. Results shows that the satisfactory variability within the popoulation exists, which is a good basis for the conservation of genepool available.

Key words: conservation, European White Elm, genepool, seedlings, Ulmus effusa, variability.

Introduction

European White Elm (*Ulmus effusa* Wild., syn. *U. laevis* Pall.) is one of the three autochthonous species of familiy *Ulmaceae* Mirb. in Serbia. Unlike Field Elm (*Ulmus minor* Miller) and Mountain Elm (*Ulmus montana* With.), which occupy slightly different habitats, European White Elm (*Ulmus effusa* Wild.) is a species limited to the lowlands. Looking outside of Serbia, European white elm grows in Central and Eastern Europe (Jovanović 2007).

During the past century massive drying of elms occurred and the indications of their extinction appeared, both in natural populations and in urban areas, which consenquently lead to the reduction of genetic diversity and the danger of genetic drift. Dutch elm disease (DED) is considered to be the main cause of the often drying of these species. However, disappearance of wetlands due to drainage for agricultural production or poplar cultivation is more often considered to be the cause of European White Elm drying (Collin 2003).

In the forest fund of the Republic of Serbia, European White Elm is recognized as a rare and endangered species (Banković *et al*. 2009). From the perspective of conservation and directed utilization of forest genetic resources, European White Elm can be considered as priority species in sence of the available genepool, and the fact that conservation areas for *in situ* conservation of this species in Serbia do not exist, and the methods of *ex situ* conservation were not performed (Šijačić-Nikolić, Milovanović 2010).

The variability and growth of European White Elm seedlings were studied by many authors.

Black-Samuelsson *et al.* (2003) reported existence of a strong additive genetic variation between and within populations in growth of one-year old seedlings as response to drought stress. Witheley *et al.* (2003) also reported iner- and intrapopulation variability of one-year old seedlings. Examining of the four-year old plants of *Fraxinus angustifolia* and *Ulmus laevis*, Cicek et al. (2011), reports influence of provenance and growth density on the development of ash seedlings, but lack of significant influence on European White Elm seedlings.

Material and methods

A total of 56 trees of Europen White Elm were found, marked and georeferenced on Great War Island, near Belgrade, Serbia (Fig. 1). The trees are spatially divided into three subpopulations:

Fig. 1. Spatial distribution of subpopulations European White Elm (*Ulmus effusa* Willd.) at Great War Island

Table 1. Coordinates and basic characteristics of 14 mother trees of European White Elm (*Ulmus effusa* Willd.) at Great War Island

Subpopulation	Mark of tree on the field	Coordinates		Height (m)	Average diameter (cm)	Age
		E	N			
	13	7456215	4965040	23,1	48.7	26
I	14	7456215	4965038	7,7	15.65	13
	32	7456352	4964955	20,2	38.3	23
	18	7456050	4965266	16,7	39.5	27
	19	7456054	4965270	18,4	36.5	16
	21	7456046	4965285	9,5	31.5	16
II	33	7456138	4965226	13,7	29.35	20
	34	7456170	4965254	21	31.3	20
	35	7456150	4965257	20,9	30.4	20
	36	7456136	4965262	13,9	37.8	23
III	30	7455319	4965639	13,5	23.5	15
	31	7455137	4965585	12	23.5	17

The first subpopulation (I) consists of 24 trees located in the inshore area, the recent alluvial deposits with characteristics of β-gley, White Willow forest type (*Salicetum albae* Issl.26) on the β -gley.

The second subpopulation (II) consists of 22 marked trees inhabiting the area with a very dense canopy and impervious. It extends in the internal part of the island, close to the canal Galijaš.

The third subpopulation (III) consists of 10 trees individually dispersed throughout the forest edge or in a field. The second and the third subpopulation belong to the forest of White and Black poplar (*Populetum albo-nigra* Slav.52) the mosaic of alluvial soil, which is the final stage of development of floodplain forests of soft deciduous trees. European White Elm (*Ulmus effusa* Willd.) is seen here in the second floor of the trees, beside Black poplar (*Populus nigra* L.) and White poplar (*Populus alba* L) edificators (Šijačić-Nikolić, Milovanović 2012).

In the spring of 2011, during May, the seeds were collected from all trees where yield was recorded (Tab. 1).

Seeds were collected in May 2011 and after a short drying during the same month were sown in seed beds, seeding density 1200 seeds/m^2.

Seed beds were covered with a thin layer of the substrate made up of sand and soil in the ratio of 1:1 (Fig. 2 and Fig. 3). Irrigation was initially done

Fig. 2. Seed beds with seed partialy covered

daily until seedlings appeared, and then less frequently (every 3-4 days) (Figure 4). Each of the half-sib lines samples was taken from 50 one-year plants with bare-roots, their height (H) and root collar diameter (D) were measured. Roller's sturdiness coefficient, as the ratio of the height (cm) and diameter (mm), were calculated (Roller 1977, Ivetić 2013).

Fig. 3. View on the seed beds sown and covered

Basic statistical analysis of the data collected included the calculation of mean values, standard deviations (SD) and width variation. Clustering of the obtained mean values and the homogenity of groups were tested by Tukey HSD test. The origin of variability was examined by analysis of variance (one-way ANOVA). The interdependence of the morphological parameters was tested by calculating the Pearson correlation coefficient. Closeness (distance) of mother trees based on the above parameters was tested by cluster analysis.

Fig. 4. Appearance of seedlings after germination

Fig. 5. The layout of rows of seedlings

Table 2. Mean values of height (H), diameter (D) and Roller's sturdiness coefficient (SQ) (standard deviation (SD in parentheses), the limits for H, D, SQ and HSD test of 14 tested maternal line (ML)

N=700	H		D		SQ	
ML	MEAN VALUES (Sd)	$X_{mин}$-X_{max}	MEAN VALUES (Sd)	$X_{mин}$-X_{max}	MEAN VALUES (Sd)	$X_{mин}$-X_{max}
13	20.55 (5.92)[abc]	12.3-40.2	3.25 (1.07)[abc]	1.47-7.05	6.52 (1.35)[a]	3.73-10.1
14	19.34 (5.64)[ab]	10.4-36.5	3.13 (1.17)[abc]	1.43-6.49	6.45 (1.29)[a]	3.98-9.5
18	23.34 (6.44)[abc]	12.2-41.2	3.46 (1.31)[abc]	1.67-6.57	7.18 (1.81)[abc]	3.81-10.6
19	23.83 (8.13)[bc]	9.3-46.8	3.42 (1.59)[abc]	1.30-7.69	7.52 (1.97)[abc]	4.24-15.8
21	18.87 (7.55)[a]	7.9-45.0	2.80 (1.35)[a]	0.88-7.33	7.12 (1.48)[ab]	4.40-10.4
29	21.93 (7.29)[abc]	11.0-43.4	3.52 (1.35)[abc]	1.55-6.97	6.51 (1.44)[a]	3.25-10.3
30	29.89 (9.33)[d]	13.4-55.7	3.91 (1.66)[c]	1.79-8.86	8.29 (2.80)[c]	2.84-21.8
31	21.67 (8.87)[abc]	8.9-47.1	2.91(1.35)[ab]	1.17-6.97	7.71 (1.53)[bc]	4.44-11.5
32	20.33 (5.88)[abc]	10.6-35.8	2.89 (0.96)[ab]	1.48-5.97	7.25 (1.50)[abc]	4.03-11.1
33	24.92 (7.94)[c]	7.0-43.7	3.73 (1.32)[bc]	1.31-7.84	6.87 (1.53)[ab]	4.52-10.9
34	24.73 (7.54)[c]	10.5-43.5	3.45 (1.34)[abc]	1.11-7.96	7.53 (1.64)[abc]	3.68-11.1
35	23.41 (6.27)[abc]	7.8-38.7	3.31 (1.04)[abc]	1.73-6.00	7.36 (1.98)[abc]	3.50-12.1
36	21.84 (5.94)[abc]	11.1-35.0	3.29 (0.98)[abc]	1.36-5.24	6.88 (1.45)[ab]	4.18-9.9
37	20.48 (7.56)[abc]	6.5-35.4	2.80 (1.35)[a]	0.97-6.96	7.86 (1.91)[bc]	3.46-11.6
ALL LINES	22.5 (7.70)	6.5-55.7	3.28 (1.32)	0.88-8.86	7.22 (1.79)	2.84-21.8

Results and discussion

The highest average H (29.89 cm) and D (3.91 mm) was observed in half-sib seedlings line 30 of the parent tree (Table 2). The maximum values of 55.7 cm H and D of 8.86 mm were recorded in the same line of seedlings at the same time.

Mean values in the same column followed by different letters are statistically different for $p < 0.05$.

According to the observed parameters seedlings from 30 lines segregate into a separate group. They also show the highest variability of observed parameters. Thus, for H Sd = 9.33 with variational width of 42.30 cm for D Sd = 1.66 with the variation width of up to 7.07 mm, and for SQ Sd = 2.8 the variation width of 18.96.

Minimum value of 6.5 cm H and D of 0.97 mm were measured in seedlings of maternal line 37, while the minimum mean values of both measured parameters were recorded in the line 21.

Analysis of variance indicated that the variability of physiological parameters is the consequence of a mother tree, not a coincidence, and that the variability between seedlings of maternal lines (p = 0.00) is greater than the variability of plants within a maternal line (Table 3).

D and H showed a significant and strong positive correlation. SQ shows a relatively strong, negative correlation with D, and a weak, but significant correlation with H.

Table 3. Analysis of variance (one-way ANOVA) height (H) and diameter (D) of 14 half-sib lines of European White Elm

BETWEEN MATERNAL LINES			
CBOJCT BO	**MEAN SQUARE**	**F-RATIO**	**P-VALUE**
H	40721.00	7.74	0.00
D	1.67	3.48	0.00

Table 4. Correlations between the morphological parameters: the diameter (D), the height (H) and Roller's sturdiness coefficient (SQ) of 14 half-sib lines of European White Elm

N=700 (Casewise deletion of missing data)			
	D	**H**	**SQ**
D	1.00000		
H	0.79095*	1.00000	
SQ	-0.48323*	0.10136*	1.00000*

Figure 6 shows a constant growth of SQ with increasing of H. On the other hand, the value of SQ decreases with growth of D, to certain, approximately mean values. After that, with the increase of D, SQ begins to grow.

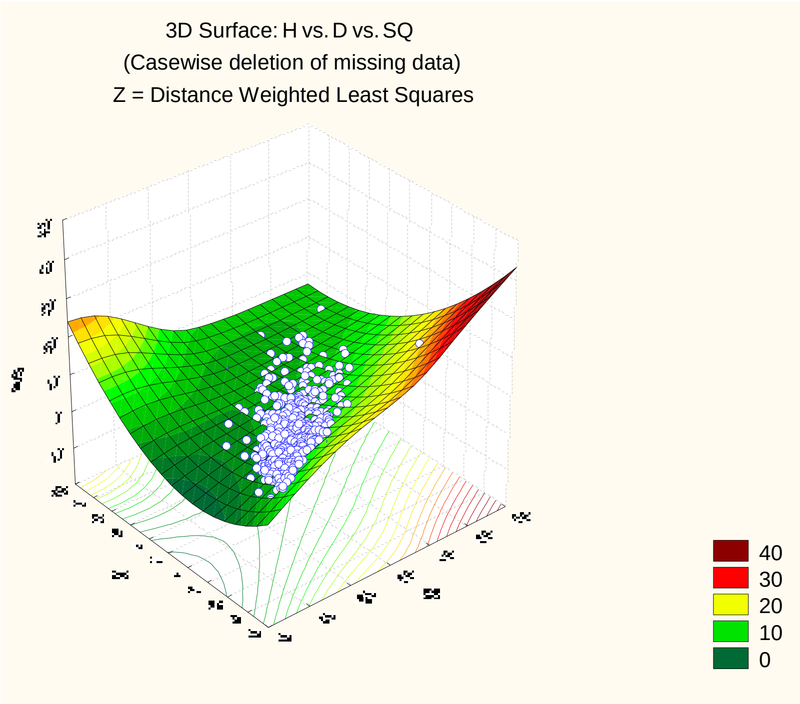

Fig. 6. Area of a combination of height (H) and diameter (D) as a predictor, as opposed to Roller's sturdiness coefficient (SQ) as the dependent variable

Cluster analysis (Fig. 7) shows clustering of examined maternal lines into three groups. The first group consists of the maternal lines 18, 19, 33, 34 and 35. The second group consists of lines 13, 14, 21, 29, 31, 32, 36 and 37. The third group consists of 30 lines, which are groups at the greatest distance with other maternal lines.

The density of growth, as a result of planting density has a strong effect on the growth of seedlings. Applied seeding density of 1,200 seeds per m^2 significantly exceeds the growth of 75 plants per m^2, where Cicek et al. (2011) found the highest values of H and D of one-year old seedlings of European White Elm with bare-root. However, it did not significantly affect the SQ, which is satisfactory and which is close to the results got by the listed authors. SQ change with increasing D should be explored, especially in the second year of growth of seedlings.

Variability within the population of parameters observed is significant, as shown by the analysis of variance, and does not depend on the spatial distribution of mother trees.

Considering the number of trees in the reference population as an appropriate method may be recommended the *in situ* conservation of genetic resources. In endangered populations of European White Elm, with a significantly reduced number of trees, may be recommended the *ex situ* conservation (Aleksic, Orlovic 2004).

For the purpose of ex situ conservation, the level of variation within the population should be compared with the close spatial populations of European White Elm of coastal areas of the Danube and Sava rivers, during their work, Whiteley et al. (2003) found that studied populations differ in the level of genetic variation within the population. Also, exploring the genetic variability of the border populations of European White Elm, Vakkari et al. (2009) suggest that differences between populations follow the structure of isolation caused by distance (isolation by distance).

Conclusion

The vulnerability of European White Elm (Ulmus effusa Wild.) population on the Great War Island, is sufficiently explained by the record that only 56 trees of this species exist, and their age structure indicates the existence of different generations of trees in the population.

According to the research of variability of morphometric caracteristics of one-year old seedlings, it can be concluded that the satisfactory variability within the popoulation exists, which is a good basis for the conservation of genepool available. Special attention should be paid to the half-sib lines whose characteristics (height, diameter and Roller's sturdiness coefficient) provide the best quality seedlings, which in this case is the line half-sib seedlings of mother tree 30. But from the aspect of conservation and directed utilization the specific genotypes which manifested the minimum dimensions such as tree seedlings of lines 21 and 37 should not be ignored.

For effective protection of genetic resources of European White Elm on the Great War Island, *in situ* and *ex situ* methods should be combinated for a long time. *In situ* conservation is already partially realized, given that it is a protected nature reserve. To apply the *ex situ* methods it is necessary to continue monitoring of half-sib lines and establish progeny tests, in order to select appropriate trees for the production of plants and to expand the species population and conservation of her genetic variability in this area.

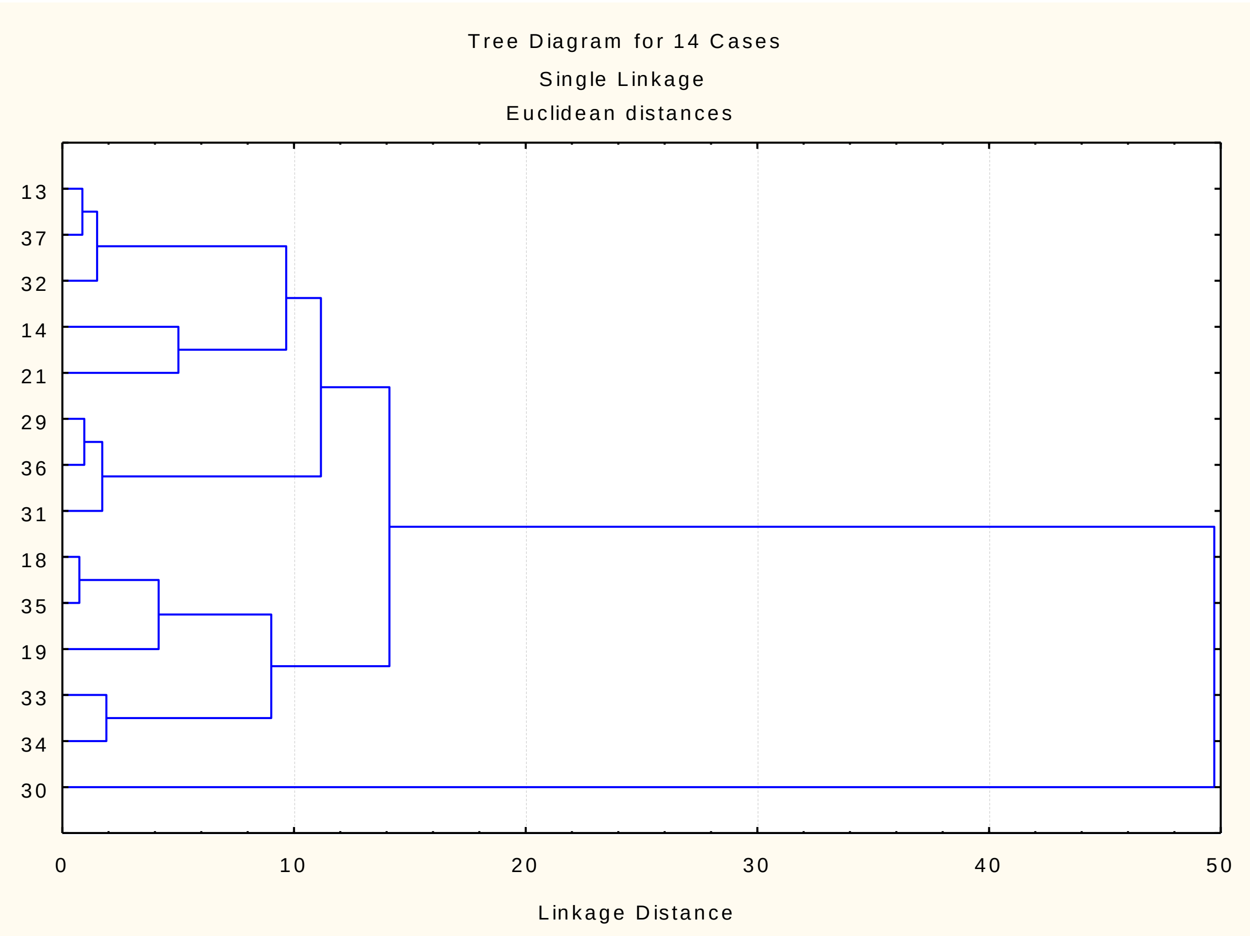

Fig. 7. Dendrogram of the cluster analysis was done on the basis of height and root collar diameter of one-half-sib seedlings of European White Elm

References

Aleksić, J., Orlović, S. 2004: *Ex situ conservation of genetic resources of field elm (Ulmus minor Mill.) and european white elm (Ulmus laevis Pall.)*. – Genetika, Vol. 36, No. 3, 221-227.

Banković, S., Medarević, M., Pantić, D., Petrović, N., Obradović, S. 2009: Šumski fond Republike Srbije-stanje i problemi, Glasnik Šumarskog fakulteta, Beograd, br. 100, (7-30).

Collin, E. 2003. EUFORGEN Technical Guidelines for genetic conservation and use for European white elm (*Ulmus laevis*). International Plant Genetic Resources,Institute, Rome, Italy. 6 p.

Black-Samuelsson S., Whiteley R. E., Junzhan G. 2003: Growth and Leaf Morphology Response to Drought Stress in the Riparian Broadleaved Tree, *Ulmus laevis* (Pall.). Silvae Genetica 52, 5-6.

Cicek E., Cicek N., Tilki F. 2011: Four-year Field Performance of *Fraxinus angustifolia* Vahl. and *Ulmus laevis* Pall. Seedlings Grown at Different Nursery Seedbed Densities. Research Journal of Forestry, 5: 89-98.

Jovanović, B. 2007: Dendrologija. Šumarski fakultet Univerziteta u Beogradu. Str. 1-536ultet, Beograd: 1-77.

Ivetić, V. 2013: Praktikum iz Semenarstva rasadničarstva i pošumljavanja. Univerzitet u Beogradu, Šumarski fakultet, 213 p..

Šijačić-Nikolić, M., Milovanović, J. 2010: Konzervacija i usmereno korišćenje šumskih genetičkih resursa, Šumarski fakultet Univerziteta u Beogradu, Beograd, 1-200.

Šijačić-Nikolić, M., Milovanović, J. 2012: Conservation and sustainable use of foerst genetic resources throught an example of watland ecosystems, International Conference: Role of research in sustainable development of agriculture and rural areas, May 23-26, Podgorica, Montenegro, Book of Abstracts, 128.

Whiteley, R.E., Black-Samuelsson, S., Jansson, G. 2003: Within and between population variation in adaptive traits in Ulmus laevis Pall., the European white elm. Forest Genetics 10(4):313-323.