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YIELD VARIABILITY AS A BASIS FOR CONSERVATION AND DIRECTED UTILIZATION OF EUROPEAN WHITE ELM (*Ulmus effusa* Willd.) GENE POOL AT GREAT WAR ISLAND

ABSTRACT

The European White Elm (*Ulmus effusa* Willd.) is a species that belongs to the group of noble broadleaves, characterized by exceptional features and wood quality. In the forests of Serbia, the European White Elm belongs to the category of rare and endangered species according to the IUCN categorization. The disappearance of wetland habitats is the primary threat to the survival of White Elm populations and to the genetic diversity of this species. Draining of wetland habitats for the needs of agriculture or cultivation of poplars leads to dramatic changes in ecosystems where the White Elm grows. As a result, fragmentation of White Elm populations into smaller populations, groups of trees and individual trees occurred, which will ultimately lead to genetic drift problems, and therefore, to the ecological instability of this species.

The population of European White Elms in the territory of the Great War Island includes more than fifty trees which occur in three spatially isolated subpopulations. This paper presents results of the analysis of morphometric characteristics of fruits (width and length) and seeds (width, length, position and germination), showing significant variability within the population.

On the basis of the obtained results, the conservation and directed utilization of White Elm genetic resources will be realized: in situ - by the selection of rare genotypes within the available gene pool and their inclusion into a network of habitat conservation and ex situ – by establishing progeny tests intended for further exploration of population genetic potentials, generative and clonal seed orchards and storing rare genotypes into the seed bank.

Keywords: Great War Island, European White Elm, gene pool, yield, variability, conservation

INTRODUCTION

The European White Elm (*Ulmus effusa* Willd. 1787; Syn: *U. pedunculata* Foug. 1787, U. *leavis* Pallas 1784) belongs to the family *Ulmaceae* Mirb., which

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includes 15 genera with more than 150 species, whereof 18 species occur in the northern moderate zone (Jovanović, 1970).

The area is located in central and eastern Europe, being rather limited to the lowlands. The habitat of *Ulmus* L. is characterized by great diversity, therefore some members of the genus grow by the banks of large rivers (*U. minor* Mill., *U. laevis* Pall., *U. americana* L., *U. rubra* Mühl., *U. davidiana* Planch.), while the other species (*U. glabra* Huds) prefer rather hilly areas and higher altitudes (Zebec et al., 2010). The European White Elm mostly occurs in willow and poplar, field ash and common oak habitats, growing in communities with the following species: *Salix alba, Salix fragilis, Populus alba, Populus nigra, Fraxinus angustifolia, Quercus robur, Frangula alnus, Rubus ceasius*, etc… Being a component of coastal forests and lower latitudes, it is tolerant of wetlands and periodic floods (Jović et al., 2009). The disappearance of wetlands represents a serious threat to the survival of the European White Elm population and to genetic diversity of this species. Draining of wetland habitats for the needs of agriculture or cultivation of poplars leads to dramatic changes in ecosystems where the White Elm grows. As a result, there was a fragmentation of White Elm populations into smaller populations, groups of trees and individual trees, which will ultimately lead to genetic drift problems, and therefore, to ecological instability of this species.

According to the REFORGEN database on forest genetic resources, the European White Elm is categorized as an endangered species, at least in the Denmark area, which has provided its data to the database (REFORGEN, 2003). In all five countries that have provided their data to the database (Albania, Czech Republic, Denmark, Finland and Lithuania), the European White Elm is considered to be a species very important for genetic conservation. However, in all these countries (except Denmark) it also has utilization value. In the forest fund of the Republic of Serbia, the European White Elm is deemed a rare and endangered species (Banković et al., 2009). This implies the need to gather all data regarding the conditions and potentials of the remaining natural European White Elm populations and their genetic variability for the purpose of updating the database and including the information from Serbia therein. There are no conservation areas in Serbia for in situ conservation of the European White Elm, nor any applicable ex situ conservation methods.

MATERIALS AND METHODS

The European White Elm occurs in the territory of natural heritage "The Great War Island" in common willow forests (*Salicetum albae*) on recent, wet and layered alluvial drifts, as well as in white and black ash forests (*Populetum albo-nigrae* Slav.) on a mosaic of different alluvial soils. The importance of this species for forest ecosystems of The Great War Island is revealed in the fact that in this area it represents the only remaining parts of former natural populations with a rather small abundance in the forest management unit "The Great War Island", which indicates its gradual disappearance from this area. This is

particularly important if we take into consideration the fact that the European White Elm is considered to be a rare and endangered species by the forest fund of the Republic of Serbia (Banković et al., 2009). According to the data from The special basis for managing forests in the forest management unit "The Great War Island" 2008-2017, the total volume is insignificant and amounts to 2.9 m^3. Through detailed terrain recognition a total of 56 European White Elm trees were registered, which occur in three spatially isolated sub-populations (Fig. 1). This does not neglect the possibility that there are more trees in other parts of the island, since access to the terrain is rather difficult.

Figure 1: Spatial distribution of the European White Elm trees (*Ulmus effusa* Willd.) on the territory of The Great War Island

For the purpose of determining the yield at the level of population, seeds were collected in spring 2011 from all trees where the yield was registered (Fig. 2).

Figure 2: Analysis of quantity and quality of yield from different European white elm trees (*Ulmus effusa* Willd.) on the territory of The Great War Island (Pictures taken on 12 May 2011)

Seed germination was examined in a standard sample (4 x 100 seeds) during 28 days. A mass of 1000 grains from each tree was determined.

The analysis of morphometric features of fruits and seeds was conducted on a sample that consisted of 100 fruits from each tree (Fig. 3). The following characteristics were analysed: fruit width (FW), fruit length (FL), seed width (SW), seed length (SL), seed position and appearance of the top.

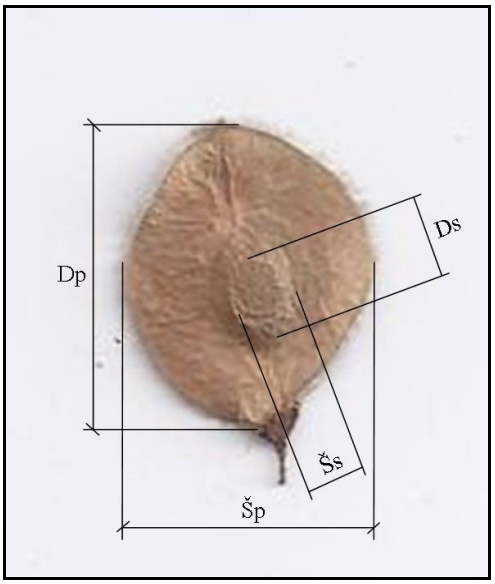

Figure 3: Analysed morphometric characteristics of European White Elm fruits and seeds

The data collected in 9600 measuring rounds was processed by the computer program "Statgraph". The average values and LSD tests were determined for each characteristic.

RESULTS AND DISCUSSION

Results of the seed germination analysis for different European White Elm trees are shown in Chart 1.

Pursuant to the above mentioned, a conclusion can be derived that the seed germination ranges from 16.5 (tree 30) to 87.5% (tree 18). The majority of analysed trees (14 out of 16) had a high level of germination (over 63.0%).

When compared to the data of Stilinović from 1985, who states that the average germination of fresh seed amounts to 45-60%, it can be concluded that there is a high seed quality at the level of the tested trees.

Variability of mass of 1000 European White Elm grains at the level of the tested trees (Tab. 1) ranges from 5.15 (tree 30) to 11.60 (tree 37).

When compared to the literature data, which states that the mass of 1000 grains amounts to around 7.5 g (Stilinović, 1985) it can be concluded that certain trees (total of 7) have significantly higher values than stated.

Table 1: Seed germination and mass of 1000 European White Elm seeds at the level of the tested trees

Tree	Seed germination	Seed mass
13	81.5	7.20
14	85.5	7.05
18	87.5	9.25
19	84.0	10.85
21	60.5	9.10
27	63.0	10.80
28	27.0	7.25
29	86.0	7.10
30	16.5	5.15
31	76.0	6.75
32	77.5	9.00
33	68.0	7.60
34	72.5	7.60
35	85.0	8.55
36	80.0	7.40
37	68.0	11.60

The variability of morphometric characteristics of fruits and seeds from different tested trees is shown in Chart 2 through average values and LSD tests of measured features. The differences obtained between average values of morphometric characteristic are statistically important.

On the basis of the presented results it can be concluded that the fruit width ranges from 8.29 (tree 31) to 14.12 mm (tree 28) and the fruit length ranges from 12.53 (tree 33) to 20.27 (tree 28).

When compared to the literature data stated by Stilinović (1985), where the fruit length is 12-15 mm and width is 7-8 mm, the obtained values seem to be significantly higher. However, the results correspond to the results of research conducted by Isajev (1979) for the European White Elm population on Ada Ciganlija, nearby Belgrade, as well as for the population that belongs to the forest selection in Klenik.

The seed width ranges from 3.10 (tree 14) to 4.80 mm (tree 28) and the seed length ranges from 4.55 (tree 14) to 7.11 mm (tree 28). With almost all analysed trees the seeds are located in the upper part of the wing, except with tree 30 where the appearance of the wing top is different (full) from the other trees (split wing top).

Table 2: The average value and LSD test of characteristics measured on European White Elm fruits and seeds

	Tree	Average value	Homogeneous groups		Tree	Average value	Homogeneous groups
FRUIT WIDTH (mm)	**31**	8.29	X	FRUIT LENGTH (mm)	**33**	12.53	X
	36	8.97	X		**18**	12.86	XX
	13	8.98	X		**31**	12.96	XX
	35	9.14	XX		**34**	13.05	XXX
	14	9.36	XX		**14**	13.31	XXX
	18	9.61	XX		**13**	13.39	XX
	34	9.80	XX		**36**	13.58	X
	33	9.84	XX		**32**	14.08	X
	37	10.06	XX		**29**	14.42	X
	27	10.08	XX		**35**	14.45	X
	29	10.16	X		**37**	15.45	X
	21	10.19	X		**19**	15.68	XX
	32	10.81	X		**21**	15.90	X
	19	11.02	X		**27**	16.02	X
	30	13.57	X		**30**	17.28	X
	28	14.12	X		**28**	20.27	X
SEED WIDTH (mm)	**14**	3.10	X	SEED LENGTH (mm)	**14**	4.55	X
	13	3.12	X		**32**	4.64	XX
	29	3.36	X		**13**	4.73	XX
	31	3.46	XX		**29**	4.80	X
	33	3.56	XX		**33**	5.05	X
	32	3.62	XX		**18**	5.27	X
	35	3.70	X		**36**	5.37	X
	36	3.91	X		**35**	5.63	X
	18	3.94	X		**34**	5.63	X
	30	4.08	X		**31**	5.63	X
	19	4.23	X		**27**	5.73	X
	27	4.27	X		**30**	5.77	X
	34	4.29	X		**37**	6.02	X
	37	4.43	X		**19**	6.47	X
	21	4.57	X		**21**	6.74	X
	28	4.80	X		**28**	7.11	X
SEED POSITION	**35**	1.00	X	APPEARANCE OF THE WING TOP	**18**	1.00	X
	37	1.00	X		**31**	1.01	XX
	36	1.00	X		**19**	1.01	XX
	21	1.00	X		**33**	1.02	XX
	18	1.00	X		**36**	1.03	XX
	28	1.00	X		**35**	1.05	XX
	29	1.00	X		**34**	1.06	XXX
	14	1.00	X		**14**	1.07	XXX
	31	1.00	X		**32**	1.07	XXX
	32	1.00	X		**37**	1.08	XX
	33	1.00	X		**27**	1.13	XX
	27	1.00	X		**21**	1.19	XX
	13	1.02	XX		**29**	1.25	X
	19	1.04	X		**13**	1.34	X
	34	1.18	X		**28**	1.98	X
	30	2.07	X		**30**	2.00	X

Legend: seed position: 1- in centre of wing, 2 – in upper part of wing, 3 – in lower part of wing; appearance of wing top: 1 - split, 2 – full wing top

CONCLUSION

The analysis of yield quality and quantity, completed within the European White Elm population on The Great War Island, indicates a high level of genetic variability of analysed fruit and seed morphometric characteristics, as well as good reproductive ability of this population.

According to the obtained results, it is necessary to conduct a selection of "plus" trees whose seeds will be used for establishing progeny tests. The assessment of adaptive and production potentials of different lines of half-sibs in progeny tests is used for the selection of elite trees, which represent a basis for seed collection and seedling production, aimed at spreading the population of this species and preservation of genetic variability in this area. This contributes to ex situ conservation of the available gene-pool.

In situ conservation is already partially achieved, especially if we take into consideration the fact that this is a protected natural heritage area where the impact of anthropogenic factors is limited. For the purpose of protecting the European White Elm genetic resources in the area of The Great War Island, it is necessary to use a combination of in situ and ex situ conservation methods over a longer period of time.

A high level of variability in the selection of plus trees is of crucial importance for the preservation of adaptability to a wide range of environmental conditions, especially in the case of sensitive wetland habitats, such as The Great War Island. However, the role of scientific/research institutions is to ensure better recognition of the existing situation within the population and individual variability of the European White Elm, to determine connections between genetics and environmentally/economically important characteristics of individual trees, and through their respective research, to contribute to the inclusion of genetic conservation into commercial trends and required trends of intensive environmental protection.

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VARIJABILNOST URODA KAO OSNOVA ZA KONZERVACIJU I USMERENO KORIŠĆENJE GENOFONDA VEZA (*ULMUS EFFUSA* WILLD.) NA VELIKOM RATNOM OSTRVU

SAŽETAK

Vez (*Ulmus effusa* Willd.) je vrsta koja pripada grupaciji plemenitih lišćara, koji se odlikuju izuzetnim karakteristikama i kvalitetom drveta. U šumama Srbije, prema IUCN-katrgorizaciji, vez spada u grupu rijetkih i ugroženih vrsta. Nestanak vlažnih staništa predstavlja osnovnu prijetnju po opstanak populacija veza i genetičkog diverziteta ove vrste. Isušivanje vlažnih staništa, za potrebe poljoprivrede ili kultivacije topola, dovodi do dramatičnih promjena u ekosistemima u kojima je vez zastupljen. Kao posljedica toga, došlo je do fragmentisanja populacija veza na male populacije, grupe stabala i pojedinačna stabla, što, neminovno, dovodi do problema genetičkog drifta, a samim tim i do ekološke nestabilnosti ove vrste.

Populaciju veza, na teritoriji Velikog ratnog ostrva, čini nešto više od pedeset stabala koja se javljaju u tri subpopulacije koje su prostorno izolovane. U radu su prikazani rezultati analize morfometrijskih svojstava plodova (širina i dužina) i sjemena (širina, dužina, položaj i klijavost), koji ukazuju na značajnu unutarpopulacionu varijabilnost.

Na bazi dobijenih rezultata realizovaće se zaštita i usmjereno korišćenje genetičkih resursa veza: in situ – putem selekcije rijetkih genotipova unutar raspoloživog genofonda i njihovim uključivanjem u mrežu konzervacionih staništa i ex situ – osnivanjem testova potomstva, radi daljeg upoznavanja genetičkog potencijala populacija, klonskih i generativnih semenskih plantaža i skladištenjem sjemena rijetkih genotipova u banku sjemena.

Ključne riječi: Veliko ratno ostrvo, vez, genofond, urod, varijabilnost, konzervacija