**UDC: 582.623(497.113)**

Original scientific paper *Izvorni naučni rad*

# EFFECT OF EARLY PREPARATION AND SLOPE ASPECT ON SURVIVAL AND GROWTH OF WHITE POPLAR ROOTED CUTTINGS

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**Abstract:** Optimization of nursery procedures is important part of introduction of white poplar genotypes in common practice. In this case we examined reaction of three genotypes of white poplar (*Populus alba* L.) on term of cutting preparation and slope aspect by survival and growth of rooted cuttings in PE "Vojvodinašume" nursery „Ratno ostrvo", near Novi Sad. There were two treatments concerning term of cuttings' preparation: a) middle of March (cuttings were stored in cool chamber at 2±1°C) and b) the day before planting at the first half of April. Also, there were examined the effect of slope aspect of nursery area: a) East-northeast, and b) West-southwest facing slope. Gained results suggest better survival and growth of rooted cuttings made at the middle of March and better survival and growth on area oriented to the West-southwest. The gained effects were mostly consistent for all examined genotypes (better results on West-southwest aspect and after early term of preparation). These results suggest that the research on the influence of terms of cuttings' production and the slope aspect could be important issues in creation and optimization of nursery technology suitable to the specificities of white poplar clones.

**Keywords:** *Populus alba*, nursery production, clonal technology

## *EFEKAT RANE PRIPREME REZNICA I EKSPOZICIJE TERENA NA PREŽIVLJAVANJE I RAST OŽILJENICA BELE TOPOLE*

***Izvod:*** *Optimizacija procedura u rasadničkoj proizvodnji je važan deo uvođenja genotipova bele topole u praksu. U ovom slučaju ispitana je reakcija je tri genotipa bele topole (Populus alba L.) preživljavanjem i rastom ožiljenica na rok izrade reznica i ekspoziciju u rasadniku "Ratno ostrvo", JP "Vojvodinašume", u blizini Novog Sada. Ispitana su dva tretmana roka pripreme reznica: a) sredina marta (reznice su čuvane u hladnjači na 2±1°C) i b) dan pre sadnje reznica u prvoj polovini aprila. Takođe je ispitan i uticaj ekspozicije rasadničke površine: a) istok-severoistok i b) zapad-severozapad. Dobijeni rezultati ukazuju na bolje preživljavanje i rast ožiljenica od reznica koje su pripremljene sredinom marta, kao i bolje*

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*preživljvanje i rast ožiljenica na površini sa zapad-jugozapadnom ekspozicijom. Dobijeni efekti su bili prisutni uglavnom kod svih ispitivanih genotipova (bolji rezulati na ekspoziciji zapad-jugozapad i raniji rok pripreme reznica). Ovi rezultati ukazuju da bi istraživanja uticaja roka izrade reznica i ekspozicije terena mogli da budu važna komponenta u stvaranju i optimizaciji rasadničke tehnologije koja odgovara specifičnostima klonova bele topole.*

*Ključne reči: Populus alba, rasadnik, klonska tehnologija*

## INTRODUCTION

White poplar (*Populus alba* L.) is adoptable species, useful in various forms of afforestation (Rončević et al., 2012). It has many important properties: fast growth, tolerance to many abiotic and biotic agencies, stump and root sprouting etc. However, opposite to black poplars, it is characterized by poor rooting of hardwood cuttings, the essential trait for mass vegetative propagation in practice. The possibility of massive and relatively cheap vegetative propagation of superior genotypes is the crucial step in the improvement white poplar production. One way of the improvement of rooting of white poplar hardwood cuttings is selection of easy-to-root genotypes, which is one of the main goals in white poplar breeding. However, it is not an easy task, considering the importance of combining this trait with other important and desired traits like: fast vigorous growth, tolerance to pests and diseases, stem straightness etc. In that sense, the effort should be made also to improve nursery technology and adjust it to the specificities of particular genotype (Kovačević et al., 2002; Kovacevic et al., 2008a). The principal aim of this effort is activation of pre-formed primordia (Smith and Wareing, 1972) that form so called "bark roots". These roots, formed at the beginning of cuttings' rooting, are of crucial importance for cuttings survival, probably due to the mitigation of risk of stress caused by imbalanced growth of shoot and root system in this phase (Kovacevic et al., 2009). Kovačević et al., (2014) made an attempt to stimulate rooting of hardwood cuttings of white poplar clones with powder formulations with indolbutiric acid and cobalt chloride. However, the effect of examined preparations was considerably dependent on clones and soil properties.

There are numerous factors influencing rooting of poplar hardwood cuttings, thoroughly listed by Kovacevic et al., (2008a). De Almeida et al., (2017) review the efforts in analysis of environmental control of cuttings' rooting in *Eucaliptus* and *Populus* species, suggesting that they are concentrated on control of irradiance, temperature, water availability, mineral nutrition and beneficial root-associated microorganisms. Stage and Salas, (2007) within the process of the model design for the prediction of forest productivity in the temperate zone, stress the importance of slope aspect, beside slope inclination and elevation by their effect of heat load of the slope area. According to Eggens et al., (2007), there is difference in physiological status of a white poplar shoots and cutting prepared from them throughout the dormant period, suggesting that there are significant differences in the rooting ability during that period.

In this work, we are dealing with the orientation of slope of nursery production area and the term of cutting preparation. The aim is to evaluate the

importance of these factors on white poplar cutting survival and further growth of rooted cuttings.

## MATERIAL AND METHODS

The nursery trial was established in the nursery "Ratno ostrvo" of PE "Vojvodinašume", near Novi Sad (45°17'05''N 19°54'38''E). Three genotypes were examined: Italian clone *Populus alba* cl. Villafranca, and two experimental Serbian selections: *P. alba* cl. L-12 and *P. alba* cl. L-80.

The trial was established in order to examine the effect of slope orientation and term of cuttings' preparation. There were two treatments considering slope orientation of nursery area. Areas are close to each other: one is facing to the East-northeast (Site 1) and the other to the West-southwest (Site 2), with gently slope inclination of 4% and 1%, respectively.

Soil on both sites was characterized by loamy texture class of examined surface layer (depth 0-20 cm), with dominant part of fine sand and silt (cca. 38 and 41 %, respectively) (Table 1), while the pH was 7,94 for the Site 1 and 7,72 for the Site 2. Thus, we assume that two examined sites (Site 1 and Site 2) did not defer considerably in examined soil properties.

**Table 1.** Particle size composition and textural class of examined sites
***Tabela 1.*** *Granulometrijski sastav i teksturna klasa ispitivanih lokaliteta*

| Nursery area<br>*Rasadnička površina* | Coarse sand<br>*Krupan pesak* | Fine sand<br>*Sitan pesak* | Silt<br>*Prah* | Colloid clay<br>*Koloidna glina* | Total sand<br>*Ukupan pesak* | Total clay<br>*Ukupna glina* | Texture class<br>*Teksturna klasa* |
|---|---|---|---|---|---|---|---|
| Site 1<br>*Lokacija 1* | 2.9 | 39.1 | 43.0 | 15.1 | 42.0 | 58.0 | Loamy<br>*Ilovasto* |
| Site 2<br>*Lokacija 2* | 1.7 | 37.9 | 39.5 | 20.9 | 39.6 | 60.4 | Loamy<br>*Ilovasto* |

Also, the influence of the term of preparation of cuttings was examined, where one lot of cuttings was prepared in the middle of March 2018, and the other in the first half of April 2018. The cuttings that were prepared in the earlier term were stored in cool chamber on the temperature of 2±1°C.

The trial was designed as completely randomized, in three repetitions, with fifty planted cuttings per plot and spacing 25 by 120 cm. The trial was mechanically weeded and irrigated when it was necessary throughout the growing season. At the second half of September 2018 the height of rooted cuttings were measured and the survived rooted cuttings were counted. Based on these measurements, the following parameters were calculated at the level of repetitions: a) the mean height of the rooted cutting, b) the percentage of survived cuttings, c) and the percentage of cuttings that gave plants higher than 250 cm. These data were the basis for further statistical analysis.

In the statistical analysis three-way analysis of variance was used, as well as the Tukey's HSD (honest significant difference) test, at the level of $\alpha$=0.05, in order to examine the significance of differences between examined treatments. The

data of the percentage of survival and parentage of cuttings that gave plants higher than 250 cm was transformed by arcsin-transformation (arcsin $\sqrt{x}$) in order to meet normal distribution of frequencies. All statistical procedures were performed by Statistica for Windows version 13 (TIBCO Software Inc., 2017).

## RESULTS AND DISCUSSION

According to the results of analysis of variance, the influence of slope orientation and term of cuttings' preparation significantly influenced variation of all three examined traits. However, no other examined source of variation, except the third level interaction for cutting' survival, achieved significant effect on variation of any examined trait (Table 2). The same could be concluded according to the contribution of examined sources of variation tot the total variance, where contribution of slope orientation, term of cuttings' preparation dominates in all examined characters, while interaction of all three examined factors dominates in survival and partition of plants higher than 250 as well (Graph 1).

**Table 2.** Three-way analyses of variance for examined sources of variation and traits in white poplar clones
***Tabela 2.*** *Trofaktorijalna analiza varijanse za ispitivane izvore variranja i svojstva klonova bele topole*

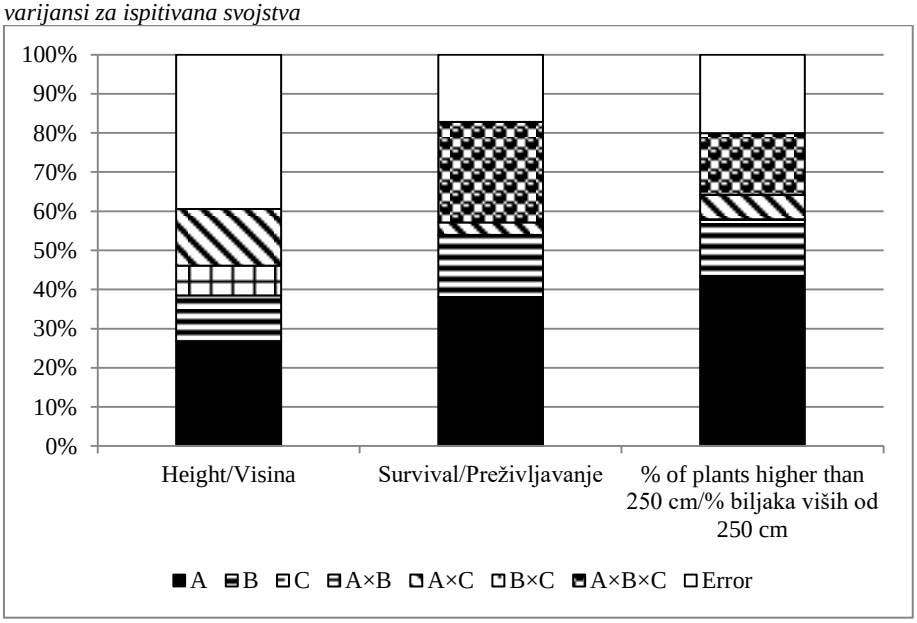
| Sources of variation *Izvori variranja* | Degree of freedom *Stepeni slobode* | F-test[a)] | | |
|---|---|---|---|---|
| | | Shoot height *Visina izbojka* | Cuttings' survival *Preživljavanje reznica* | Partition of rooted cuttings higher than 250 cm *Udeo ožiljenica viših od 250 cm* |
| Slope orientation (A) *Ekspozicija (A)* | 1 | 13.24 ** | 40.89 ** | 40.00 * |
| Preparation term (B) *Rok pripreme (B)* | 1 | 6.33 * | 17.68 ** | 13.86 * |
| Genotype (C) *Genotip (C)* | 2 | 0.15 | 0.41 | 0.08 |
| Interaction A×B *Interakcija A×B* | 1 | 2.73 | 0.27 | 1.08 |
| Interaction A×C *Interakcija A×C* | 2 | 3.20 | 2.11 | 2.84 |
| Interaction B×C *Interakcija B×C* | 2 | 0.10 | 0.68 | 0.33 |
| Interaction A×B×C *Interakcija A×B×C* | 2 | 0.64 | 5.49 * | 3.37 |
| Error *Pogreška* | 24 | | | |

[a)] *Labels for F-test: * - significant at the level $\alpha_{0,05}$ ** - significant at the level $\alpha_{0,01}$*
[a)] *Oznake u F-testu: * - značajno za nivo $\alpha_{0,05}$ ** - značajno za nivo $\alpha_{0,01}$*

Considering results of Tukey's test, there were poor differences between examined treatments in shoot height. Only in clone Villafranca, rooted cuttings were significantly higher after early term of cuttings' preparation, but only on the area facing East-northeast. The differences are more obvious in cuttings' survival. The survival was better after early cuttings' preparation in clone L-12 on area facing West-southwest and in Villafranca on area facing East-northeast. Also, for both terms of preparation the survival of cuttings of clone L-80 better survived on area facing west southwest than on area facing east northeast. Also, in Villafranca the survival after early term of preparation was two times better on area facing West south-west than on area facing East-northeast. This example that explains the significant effect of second level interaction on variation of cuttings' survival, present also the significant difference of examined clones in their reaction to the slope aspect and term of preparation and emphasize the necessity of design of nursery technology adopted to the specificities of clones.

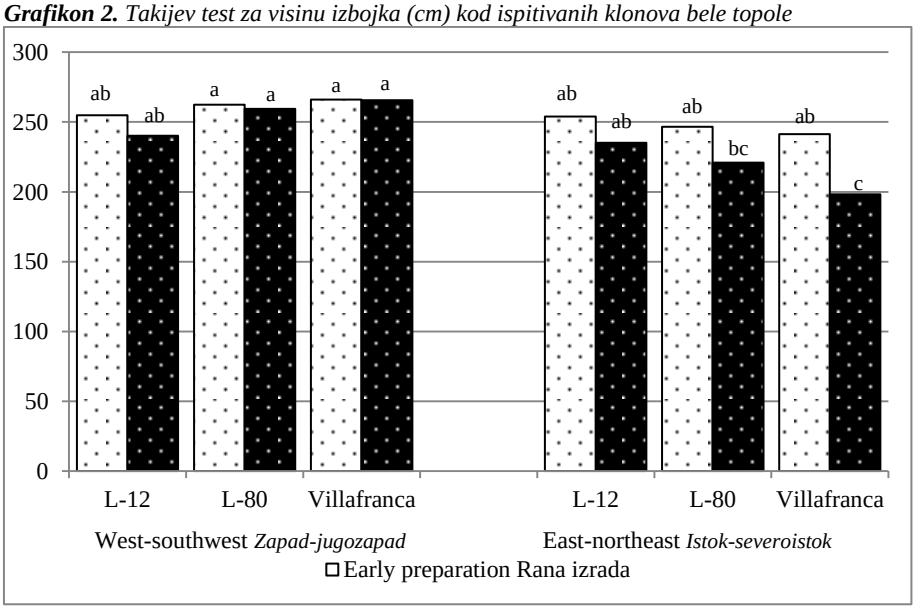
**Graph 1.** Contribution of expected variances of examined sources of variation to the total expected variance for examined characters

***Grafikon 1.*** *Doprinos očekivanih varijansi ispitivanih izvora variranja ukupnoj očekivanoj varijansi za ispitivana svojstva*

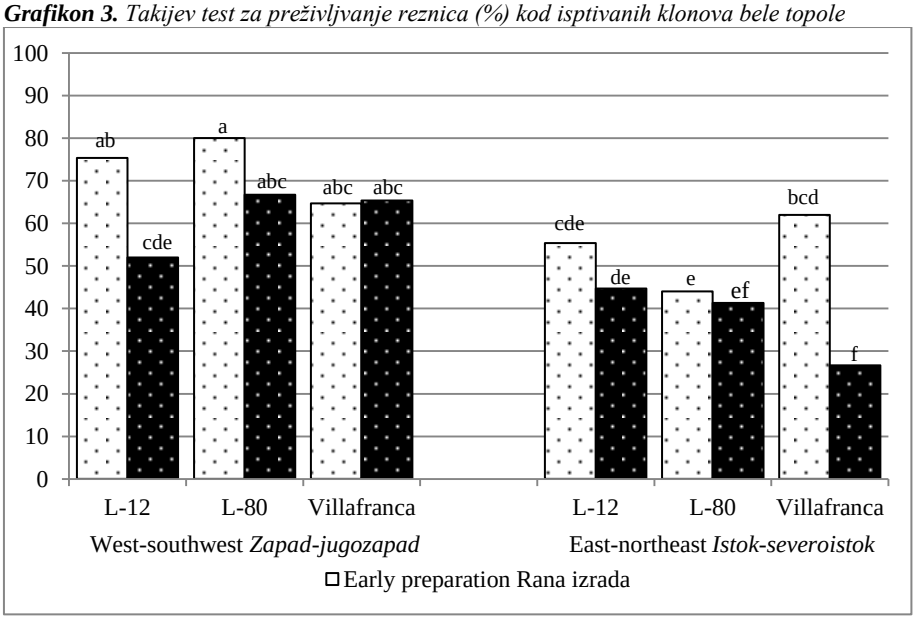



Very informative was also partition of rooted cuttings higher than 250 cm that showed similar relation between treatments but more clearly (Graph 4). It is very important parameter since, by standards of PE "Vojvodinašume", white poplar plants higher than 250 cm are considered as first class plants.

**Graph 2.** Tukey's HSD test for shoot height (cm) in examined white poplar clones
***Grafikon 2.*** *Takijev test za visinu izbojka (cm) kod ispitivanih klonova bele topole*




**Graph 3.** Tukey's HSD test for cutting survival (%) in examined white poplar clones
***Grafikon 3.*** *Takijev test za preživljvanje reznica (%) kod isptivanih klonova bele topole*




There were also found differences in the reaction of examined clones to the term of cuttings' preparation and slope orientation. Clone L-12 differed between

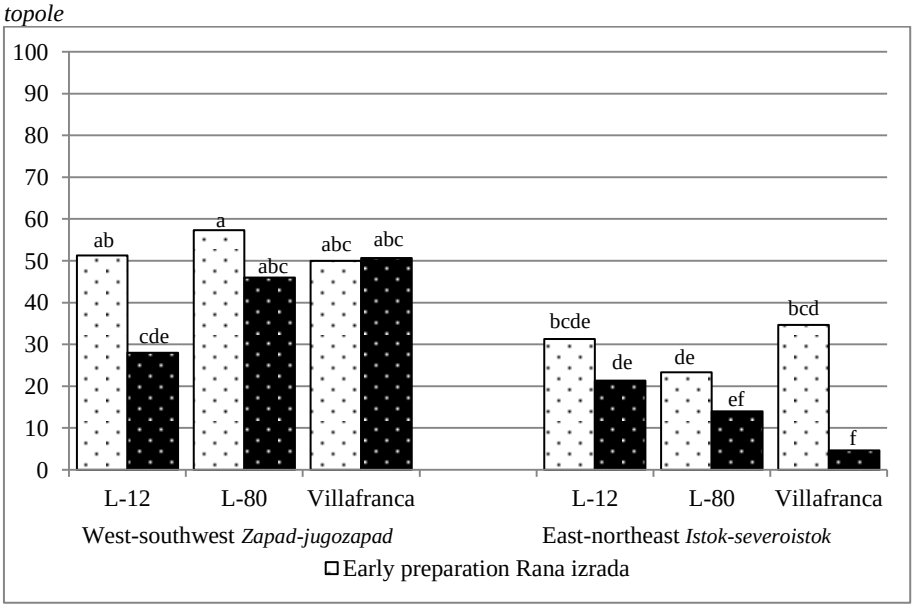
terms of preparation only on the slope facing west southwest, while Villafranca only differed between terms of preparation on the slope facing east northeast. Clone L-80 differed between examined slope orientations, but not between terms of cuttings' preparation, suggesting specific approach in optimization of nursery technology i.e. definition of clonal technology adapted to the specificities of a clone.

According to the presented results, slope orientation and preparation term showed the most significant effect on variation of examined traits, suggesting high importance of these sources of variation in survival and growth of white poplar rooted cuttings.

Although the inclinations of slopes were gentle (1% for the West southwest facing slope and 4% for the East northeast facing slope), the effect of their orientation was significant (Table 1) and considerable (Graph 2-4). Knowing that Southwest facing slopes are generally characterized by higher temperatures than Northeast facing slopes (Stage and Salas, 2007), these results suggest that higher soil temperature of the soil at West southwest facing slope could be the reason of its stimulation of rooting of cuttings of examined clones.

**Graph 4.** Tukey's HSD test for partition of rooted cuttings higher than 250 cm (%) in examined white poplar clones

***Grafikon 4.*** *Takijev test za udeo ožiljenica viših od 250 cm (%) kod ispitivanih klonova bele topole*




The importance of sufficiently high soil temperature at the beginning of cuttings' rooting is emphasized by results of Zalesny et al., (2004) and Zalesny et al., (2005). They found that soil temperature, presented by belowground growing degree days (GDD) with base temperature of 10°C, have a significant role in rooting characteristics in the first fourteen days after the planting. They even suggested that the base temperature should be 14°C in further research in northern temperate zone.

It is well known that slight changes in microrelief can effect survival and growth of poplar rooted cuttings and plants (Alkinani, 1972; Rončević et al., 2012). Also, we assume that small differences in examined soil properties could not be considered as significant, which additionally stress the importance of slope aspect on survival and growth of white poplar rooted cuttings. Thus, results gained in our work emphasize the importance of microrelief in survival and rooting of white poplar cuttings, suggesting that production area should be oriented to face west or south, in order to achieve fast warming of the soil after the planting of cuttings.

The other important factor appeared to be the term of cuttings' preparation, as it was confirmed by analysis of variance. Generally, early term of cuttings' preparation stimulated survival and further growth of rooted cuttings. The results of Eggens et al., (1972) suggest that the level of dormancy of cutting decrease during the winter. Also, results of Kovačević, (2003), Andrašev et al., (2006) and Kovačević et al., (2006) on cuttings of euramerican poplar suggest that more dormant cuttings benefit, probably due to longer period between root initiation and bud burst. They also suggest that more dormant state of cutting that are prepared in early term comparing to cuttings prepared in later term was at least partially preserved by decrease of metabolic activities by low storage temperature.

However, as it was found in black poplars by Kovačević et al., (2008b) that the term of planting of cuttings is also important, and that there is strong interaction between genotypes and terms of cuttings' preparation and planting. Also, Zalesny et al., (2004) suggest that planting of *Populus* cuttings should not be performed by calendar days but by actual and predicted soil temperatures, which is in concordance with expected climate changes. So these findings as well as this study suggest that the effect of soil temperatures and factors that influence it are of considerable importance in rooting of poplar cuttings, and that this subject deserve further research in white poplars.

Regarding presented results, it could be suggested that at West south-west and similar slope orientation cuttings of clones L-12 and L-80 should be prepared earlier then those of Villafranca, while on East-northeast aspect and area that are simmilar to it cuttings of Villafranca shoul be prepared earlier. Also, Villafranca is rather tolerant to the East-northeast slope aspect, but only after early term of cutting preparation. On the other side, clones L-12 and L-80 strongly react on the slope aspect and tolerate only West south-west aspect.

Comparing differences in the survival and growth of rooting cuttings in examined clones and in clones of section *Aigeiros* examined by Kovačević et al., (2009), it seems that reaction of white poplar clones is more intensive. That fact, in addition to generally poor survival of white poplar cuttings comparing to black poplars' suggest that the nursery technology of white poplar should be performed and improved more carefully than in black poplars'.

## Acknowledgments

This paper was realized as a part of the projects „Studying climate change and its influence on the environment: impacts, adaptation and mitigation"(43007)

financed by the Ministry of Education and Science of the Republic of Serbia and project „Improvement of lowland forests' management" financed by the PE Vojvodinasume.

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