Early Evaluation of Promising White Poplar (*Populus alba* L.) Clones in Hungary

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Abstract – White poplar (*Populus alba* L.) and its natural hybrid, grey poplar (*Populus* x *canescens*) are native stand-forming tree species in Hungary, covering 3.4 per cent of the forested area (64 000 ha). More than 70 per cent of their stands and plantations can be found on calcareous sandy sites in the Danube–Tisza region, so they play a significant role in the poplar growing of this part of the country. One of the most important tasks ahead of Hungarian poplar growers is to improve the quality of poplar stands and plantations for wood production based on selecting relatively drought-tolerant clones and cultivars. In the paper the juvenile growth and the morphological characteristics of four micropropagated white poplar clones have been evaluated on a marginal site in central Hungary. The clones *'H-337'* (*P. alba* x *P. grandidentata)* and *'H-384'* (*P. alba* x *P. grandidentata)* appear to be especially promising for quality wood production under arid hydrological conditions.

White poplar (*Populus alba* L.) / clone selection / early growth evaluation

Kivonat – Igéretes fehér nyár klónok korai értékelése Magyarországon. A fehér nyár (*Populus alba* L.) és természetes hibridje a szürke nyár *(Populus* x *canescens)* őshonos, állományalkotó fafajok Magyarországon. Az erdővel borított terület 3,4%-át (64000 ha) foglalják el. Erdőállományaik és ültetvényeik több, mint 70%-a a Duna-Tisza közi meszes homokon található, így jelentős szerepet játszanak az ország ezen részének nyárgazdálkodásában. A magyar nyártermesztők előtt álló egyik legfontosabb feladat a nyárállományokban és ültetvényekben a fatermesztés minőségének fejlesztése relatíve szárazságtűrő klónok és fajták szelektálása révén. A dolgozat négy, mikroszaporítással előállított fehér nyár klón korai stádiumú növekedési és morfológiai értékelését mutatja be közép-magyarországi marginális termőhelyen. Száraz hidrológiai viszonyok mellett a *P. alba* x *P. grandidentata 'H-337'* és *'H-384'* jelű klónok lehetnek a minőségi fatermesztés szempontjából leginkább ígéretesek.

Fehér nyár (*Populus alba* L.) / klónszelekció / korai növekedés-értékelés

1 INTRODUCTION

White poplar (*Populus alba* L.) and its most important natural hybrid, the grey poplar (*Populus* x *canescens*) native to Hungary. The area of poplar stands and plantations in the country was 61400 ha in 2006 (3.4 per cent of the total forested land), with a standing volume of 10.2 million m^3 (166 m^3 ha^{-1}).

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More than 70% of the white and grey poplar stands can be found on calcareous sandy sites in the Danube–Tisza region. Native poplars have been regarded for several decades as weed tree species without any value for the timber market. In spite of this fact about 35% of the new afforestation and artificial regenerations is carried out presently with white poplar in the mentioned region. White poplar has a rich gene pool in the sand dune region in the middle of the Great Hungarian Plain and in the bottomland of big rivers (Szodfridt – Palotás 1973). In the near future, due to the establishment of national parks in these regions, considerable increases can be expected in the area of native poplars. At the same time their importance will be increasing in the large areas of marginal sites which are not suitable for hybrid poplars but can accommodate native ones *(Figure 1).*

In Hungary the range of sites optimal for poplar growing is rather limited. In the Danube–Tisza region some very important ecological factors have become unfavourable for poplar growing in the last two decades. There is insufficient precipitation during the growing season (appr.200–300 mm), and control of the rivers and canalisation have caused a drastic lowering of the ground-water table in many places. In such spots the water supply for poplars depends on the moisture content of soils, accumulating waters on the surface and on the water-storing capacity of soils. Therefore, the main aim of the selection work is to find and improve relatively drought-tolerant white poplar clones and cultivars that have good stem form providing good-quality wood material for industrial purposes (without false heartwood) and that can adapt to the changed ecological conditions (Rédei 1994).

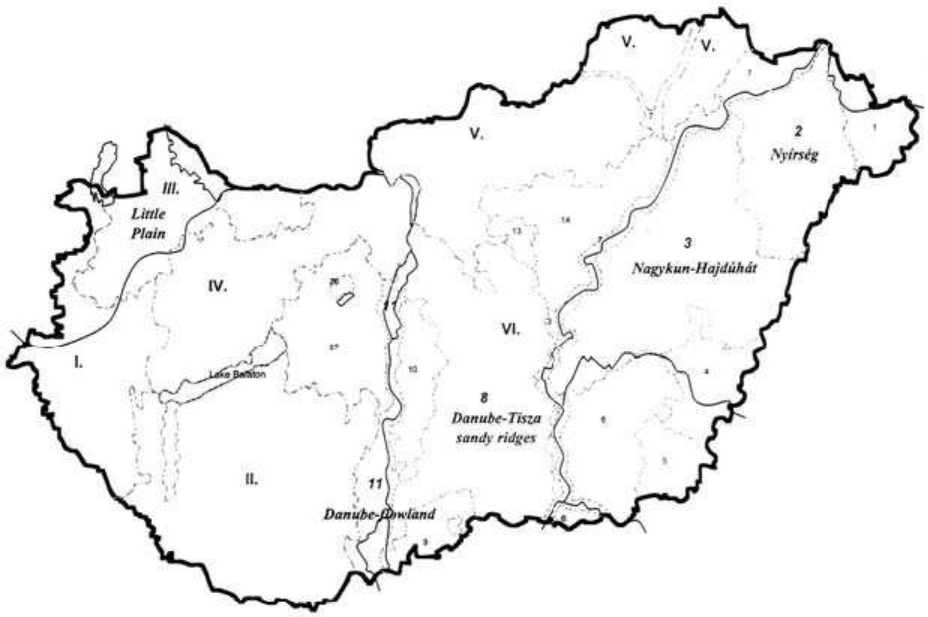

Figure 1.The main growing regions of white poplar (Populus alba L.) stands in Hungary

2 TAXONOMY AND DISTRIBUTION OF POPLARS

This section of the genus Populus (Dicmann, Kuzovkina 2008) is a complex grouping comprising the white poplars and aspens. Members of section *Populus* are distributed over temperate, boreal, and montane reaches of the Northern Hemisphere, and several are of great economic importance. As a group they are ecologically distinctive because of their clonal physiognomy and – in the case of aspens – by their common occurrence in upland habitats (Dickmann – Kuzovkina 2008).

Species crosses have yielded up to now the best results. It has to be mentioned, that the direction of crossing has importance in poplars, i.e. reciprocal crosses are genetically different. Hybrid vigour was observed in the crosses *P. alba* x *P. grandidentata* and *P. tremula* x *P. tremuloides,* which means that genetically close species, originating from different continents (usually Europe – N. America), are the most suitable partners. Such crosses may happen in nature, when the species are planted by accident close to each other *(*Mátyás 1983, Guzina 1986).

3 BRIEF SUMMARY ON BREEDING AND IMPROVEMENT OF POPLARS IN HUNGARY

The basis for the breeding and improvement programme was a series of clones obtained in the frame of co-operation, during the 1950's by the Poplar Research Institute of Italy, Belgium, the Netherlands, France, Germany and Yugoslavia, combined with the genetic heritance of Hungarian forests (*Populus nigra* and *Populus alba*). This research programme was started by the prominent scientists of the Hungarian Forest Research Institute (ERTI), Gy. Koltay and F. Kopecky. In Hungary ERTI is the most important national institution for poplar breeding and improvement. It took part in provenance testing experiments of *Populus trichocarpa, Populus deltoides* and *Populus nigra,* which were launched by FAO and IUFRO.

The number of clones selected out of progenies amounts to more than 1000. These clones, screened by early testing methods, make up a considerable part of the collection of ERTI and at the same time primary materials for clonal testing experiments. This poplar cross-breeding resulted in several excellently growing *Populus* x *canadensis* poplar clones, of which *Populus* x *canadensis Moench 'Pannonia', 'Kopecky'* and *'Koltay'* have been admitted to the official national poplar recommendation and are integral parts of the state approved and tested varieties.

Selection breeding was mostly directed to native poplars (Kopecky 1962, 1978). According to his research on native poplar hybrids, the *P. alba* x *P. grandidentata* '*H 422-1'*, the '*H 422-6'*, the *P. alba* x *P. alba* '*H 425-4'* and the *'H 325-10'* clones could have some growing-importance. The *P. alba cv. 'Bolleana' 'H 427-3'*, the *P. alba* x *P. grandidentata* '*H 422-1'* and the '*H 422-6'* clones can be planted in roadside plantations and parks for their decorative value on the whole range of suitable sites (Rédei 2000). On the calcareous sites of the Great Plain only the *P. canescens* x cv. *'Bolleana'*, the *'H 372-1'* and the *'H 372-2'* can be planted.

Selection investigations on marked individuals and populations of native poplars laid the foundation for their possible *in situ* and *ex situ* conservation. Marked gene-reserves extend to roughly 100 ha and the number of registered plus-trees is about 200 (*in situ* gene preservation). In Hungary the area of native and hybrid poplar experiments amounts to 800 ha. Geographically they are dispersed in the poplar growing regions, and therefore are suitable for drawing conclusions on clone-site interactions under the typical conditions of the country (Tóth 1996).

4 METHODS OF VEGETATIVE PROPAGATION USED FOR WHITE POPLAR CLONES

Clonal selection is a variant of individual selection, a very effective one, as both additive and non additive genetic components are utilized. Asexual propagation is very important for archivation and conservation of selected genotypes. The ease of vegetative sustenance of

individuals is maybe the greatest advantage of forest tree breeding as compared with perennial plant breeding.

The vegetative reproduction of white poplar clones can be implemented by auto-vegetative propagation. Cutting propagation has been practiced for centuries in horticulture and to some extent in forestry as well. Root cuttings have been proved to be the best method. Root cuttings are detached portions of root systems, generally 0.5 cm in diameter and about 5-10 cm in length. They are planted horizontally at a depth of 2 to 3 cm in a well-watered rooting medium. Good results can be archived with simple sowing of root cuttings in the nursery.

Greenwood cuttings are much more difficult to handle, as they are sensitive to drying-out. Greenwood cuttings of white poplar clones are rooted under shaded foil cover, they have to be carefully watered. The time required for root formation varies from two weeks to twelve weeks. Clones which root the best in early summer are usually over-wintered in a greenhouse because their root systems are not adequate to support the young ramets under outdoor winter conditions.

Four white poplar selected clones were micro-propagated during the last few years in the Micro-propagation Laboratory of Research Institute for Fruit growing and Ornamentals, Budapest–Érd in collaboration with the Hungarian Forest Research Institute. Plant tissue culture methods provide us with new means to speed up vegetative propagation of the selected clones and give us the opportunity to establish new clone trials and seed orchards with them (Rédei – Balla 2007). In spite of the numerous advantages of this method it has to be underlined that tissue culture plants must not be brought into cultivation before risks and costs are carefully considered.

5 EARLY EVALUATION OF WHITE POPLAR CLONES

Suitable observation techniques make it possible to observe some characteristics important for breeding already at an early stage of development of trees, while other characteristics are manifested at a later age. In our selection work the main selection criteria were:

- growth rate,
- adaptation to site conditions,
- stem form,
- branching habit,
- rootability of cuttings,
- resistance to pests and diseases and
- wood properties.

The trial demonstrated in this paper is allocated in the most important white poplar growing district in Hungary (in sandy ridges between the rivers Danube and Tisza).

5.1 Description of the study area

The trial discussed in this paper was allocated in subcompartment Kecskemét 40A in the Danube - Tisza interflow region (in central Hungary) in spring 2004. According to the Hungarian classification of forest site types, the main ecological characteristics of the studied area are the following: forest steppe climate zone; humidity of the air is less than 50% in July at 2 pm; during the period at the test area the annual precipitation is between 263.8-560.3 mm, hydrology: free draining; genetic soil type: humid sandy soil with very shallow rootable depth. The latitude and longitude coordinates of the experimental area are *N 46.883547, E 19.588868.*

5.2 White poplar clones found in the trial

In the clone trial the clone *'H 325'* (*P. alba* x *P. alba*), *'H 337'* (*P. alba* x *P. grandidentata*), *'H 384'* (*P. alba* x *P. grandidentata*), and *'H 425-4'* (*P. alba* x *P. alba*) as well as white poplar (*P. alba* L.) as control can be found. The experiment was set up with one-year-old micropropagated plants (in case of the clones) and one-year-old seedlings (in case of the control) in the spring of 2004. A randomised block system with three replications was used. The initial spacing was 2.5 x 2.0 m. 30 plants were planted in every replication. The total experimental area was 0,43 ha. The one-year-old *Populus* x *canescens* seedlings – as the control plants – were produced by the Kiskunsági Forestry Joint Stock Company.

5.3 Assessment of stand characteristics

The following stand parameters were measured and calculated at the age of 6 years: stem number (surviving stems), dbh.(diameter at breast height), tree height and mean tree volume. Stem volume was estimated according to the volume table for white poplar (Sopp, Kolozs 2000). According to the measurement of stem numbers the survival rate was the following: Control: 92%, 'H 425-4': 90%, 'H 337': 86%, 'H 384': 82%, 'H 325': 74%.

The collected data were analyzed by STATISTICA 8.0 (data analysis software system - StatSoft, Inc. 2008) programme including correlations and regression analysis. Analysis of variance was done for height (H) and diameter at breast height (DBH) since these parameters (particularly diameter) are highly correlated with the mean tree volume.

5.4 Tree classification

Characterization of stem quality, including their health condition was defined by using the following stem quality classes:

Class 1 – The stem is straight, cylindrical, healthy and reaching the top of the crown. Crooks are tolerated in one dimension only, up to a bend of less than twice the stem diameter. The lower two-third of the bole is free of live branches.

Class 2 – The stem is straight and healthy, forks are tolerated, but only if they are in the uppermost third of the tree. Crooks are tolerated in one dimension only, up to less than four times the stem diameter.

Class 3 – The stem is crooked, leaning and more or less damaged. Crooks may reach six times the stem diameter in one dimension and minor crookedness in a second dimension is tolerated.

Class 4 – The stem is very crooked in more than one dimension and heavy damaged. Low branching, forked trees sometimes with broken crown.

The stem quality index (see in *Table 1*) was estimated by the arithmetic average of the stem quality classes.

5.5 Results

Table 1 illustrates the most important stand structure parameters. On the basis of the data, considering the growth in height, the clones *'H 337'* and *'H 384'* provided the best results. They surpassed the control by 29 and 23 per cent, respectively. As regards the growth in DBH the above-mentioned clones surpassed the control by 24 and 23 per cent; the tendency was also the same with regard to the mean tree volume values. The effect of differences in DBH on the mean tree values seems to be very considerable (an additional 50 and 40 per cent for the above-mentioned clones). As the stem quality index is concerned, the succession from best to worst is: '*H 337*', '*H 384'*, '*H 425-4'* and '*H 325*'. According to the significance test at P = 5% level, significant differences were found in height ($SD_{5\%}$ = 1.31 m), in DBH ($SD_{5\%}$ = 1.22 cm) and in the mean tree volume values ($SD_{5\%}$ = 2.90 dm^3).

Table 1. Stand characteristics of white poplar clones at age of 6 years.

Name of clone	Mean H		Mean DBH		Mean tree volume		Stem quality index (1-4)
	m	%	cm	%	dm^3	%	
'H 325'	5.1	106	6.0	97	9	90	1.7
'H 337'	6.2	129	7.7	124	15	150	1.1
'H 384'	5.9	123	7.6	123	14	140	1.4
'H 425-4'	5.6	117	6.7	108	12	120	1.5
Control	4.8	100	6.2	100	10	100	1.9

6 CONCLUSIONS

The trees in the clone trial demonstrated in the paper thrive under site conditions that are only partly favourable for poplar growing. Considering this fact, the early evaluation showed that mostly the clones *'H-337'*and *'H-384'* seem to be suitable for poplar growing, while the clone '*H 425-4'* could be considered an alternative one for wood production.

The experiments have also demonstrated that micropropagated plants can be successfully transplanted into soil, hardened and grown in the field. Micropropagated trees have been exhibiting normal growth and appearance since they were planted. Hungary has got relatively much experience in white poplar growing. As the results suggest, systematic testing is essential in poplar breeding. However, results with a smaller probability of error can only be achieved after a longer period of research. The systematic evaluations of comparative trials set up in the past decades in Hungary will make it possible to select more reliably the white poplar clones which can meet all the requirements drafted in the introduction to this paper.

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REFERENCES

DICKMANN, D. I. – KUZOVKINA, J. (2008): Poplars and Willows of the World, with Emphasis on Silviculturally Important Species. FAO Forest Management Division Working Paper IPC/9-2; 129 p. FAO Forest Management Division, Rome, Italy, 3–64.

GUZINA, V. (ed.) (1986): Poplars and willows in Yugoslavia. Forest Research Institute, Novi Sad.

KOPECKY, F. (1962): Nyárnemesítés. [Poplar breeding] In: Keresztesi, B. (ed.): Nyártermesztés Magyarországon. [Poplar growing in Hungary] Mezőgazdasági Kiadó, Budapest, 83–117. (in Hungarian).

KOPECKY, F. **(**1978): Keresztezéses nemesítés. [Cross-breeding] In: Keresztesi, B. (ed.): Nyár- és fűztermesztés. [Poplar and willow growing] Mezőgazdasági Kiadó, Budapest, 47–65. (in Hungarian).

MÁTYÁS, Cs. (1983): An introduction to forest tree improvement. University Multipliers, Sopron.

RÉDEI, K. (1991): Improvement of Leuce-poplars growing in Hungary. Erdészeti Kutatások, 82–83**:** 304–312.

RÉDEI, K. (1994): Ígéretes fehér nyár (*Populous alba*) származások fatermése a Duna-Tisza közi homokháton. [Yield of promising *Populus alba* proveniences on the Danube–Tisza region sands] Erdészeti Kutatások, 84: 81–90. (in Hungarian).

RÉDEI, K. (1999): Promising White Poplar (*Populus alba* L.) clones in sandy ridges between the rivers Danube and Tisza in Hungary. Hungarian Agricultural Research, 8 (3): 4-8.

RÉDEI, K.(2000): Early performance of promising white Poplar (*Populus alba*) clones in sandy ridges between the rivers Danube and Tisza in Hungary. Forestry, 73 (4): 407–413.

RÉDEI, K. – BALLA, I. (2007): Vegetatív szaporítás. [Vegetative propagation] In: Rédei, K. (ed.) Homoki fehérnyárasok termesztés-fejlesztése. [Improvement of white poplar stands on sandy soils] Agroinform Publishers, Budapest. 18–23. (in Hungarian).

SOPP, L. – KOLOZS, L. (eds.) (2000): Fatömegtáblák. [Volume tables]. Állami Erdészeti Szolgálat, Budapest, 58–66. (in Hungarian).

SZODFRIDT, I – PALOTÁS, F. (1973): Hazai nyárak. [Native poplars] In: Danszky, I. (ed.): Erdőművelés II. [Silviculture II]. Mezőgazdasági Kiadó, Budapest. (in Hungarian).

TÓTH, B. (ed.) (1996): Poplar and willow growing in Hungary. Forest Research Institute, Budapest.