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Promising white poplar (*Populus alba* L.) clones in sandy ridges between the rivers Danube and Tisza in Hungary

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Summary: White poplar is a native stand-forming tree species in Hungary, covering 3.1 per cent of the forested area. More than 70 per cent of the white poplar stands can be found on calcareous sandy sites in the Danube–Tisza region, so they play a significant role in the poplar management of this part of the country. The most important task ahead of Hungarian poplar growers is to improve the quality of poplar stands and plantations based on selecting new clones and cultivars. The growth and yield of four promising white poplar clones was evaluated on a marginal site in central Hungary. The clones 'H 425-4' (*Populus alba* x *Populus alba*), and 'H 758' (*Populus alba Mosonmagyaróvár 124*) seem to be suitable for wood production, while the 'H 427-3' (*Populus alba* x *Populus alba* cv. *Bolleana*) and 'H 422-9' (*Populus alba* x *Populus grandidentata*) clones (with decorative stem form) could be better used for tree lines and ornamental plantations.

Key words: Populus alba, clonal selection, experimental plantations

Introduction

White poplar (*Populus alba* L.) and its most important natural hybrid, the grey poplar (*Populus x canescens*) are native poplar species in Hungary. The area of poplar stands and plantations in the country was 59 thousand ha in 2005 (3.1 per cent of the total forested land), with a standing volume of 9.6 million m^3 (163 m^3 ha^{-1}).

More than 70% of the white poplar stands can be found on calcareous sandy sites on the Danube–Tisza region. Native poplars have been regarded for several decades as weed tree species without any value for timber market. In spite of this fact about 35% of the new afforestations and artificial regenerations is carried out presently with white poplar in the mentioned region. White poplar has a rich gene pool on the sand dune region in the middle of the Great Hungarian Plain and on the bottomland of big rivers. 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 the Danube–Tisza region some very important ecological factors have become unfavourable for poplar growing in the last two decades. There is no sufficient precipitation during the growing season (appr. 150–200 mm), and the rivers' control 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 white poplar clones and cultivars that have good shape, provide good-quality wood material for industrial purposes (without false heartwood), and that can adapt to the changed ecological conditions (*Rédei, 1994*).

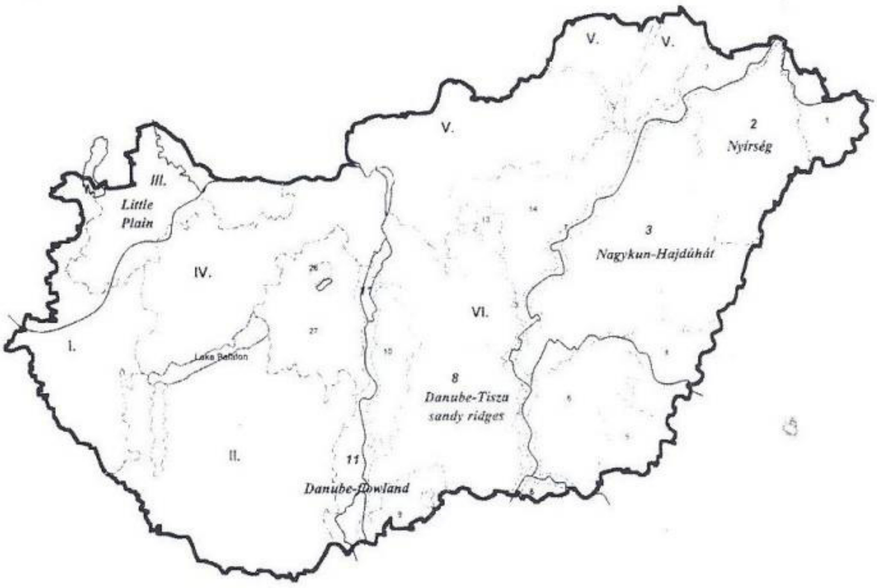

Figure 1 The main growing regions of white poplar (*Populus alba* L.) stands in Hungary

Brief summary on breeding and improvement of poplars in Hungary

The basis for the breeding and improvement programme was a series of clones given 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* & *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. In the course of breeding activities over four decades, about 80 000 seedlings were produced and tested by ERTI, of which 50% were among interspecific and intraspecific hybrids of the *Aigeiros* section, 15% of the *Leuce* section and 35% of the *Tacamahaca* section.

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 euramerican poplar clones, of which *Populus x euramericana* 'Pannonia', 'Kopecky' and 'Koltay' have been admitted to the official national poplar clone-choice 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. 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. Some parameters of three promising clones growing under different site conditions can be seen in *Table 1*.

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 relations under the typical conditions of the country.

Methods

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. The responses of clones under different environmental conditions is a result of their greater or smaller adaptability in regard to survival, rate of growth, resistance to damages, etc.

Description of study area

In the past 20 years the Hungarian Forest Research Institute established several comparative trials with white

Table 1 Some parameters of three promising clones at age of 15

Locations	Iharos				Bajti				Pandúr				Tököl			
Name of clones	Number of measured trees	Mean height m	Mean dbh cm	Mean tree volume m^3	Measured pcs	Mean height m	Mean dbh cm	Mean tree volume m^3	Measured pcs	Mean height m	Mean dbh cm	Mean tree volume m^3	Measured pcs	Mean height m	Mean dbh cm	Mean tree volume m^3
P. alba x P.grandidentata 'H 422-1'	10	20	25	0.5	9	15	29	0.6	5	15	30	0.6	4	13	24	0.4
P. alba x P.grandidentata 'H 422-6'	9	18	36	1.0	12	15	28	0.6	5	18	41	1.3	3	13	28	0.5
P. alba x cv. 'Bolleana' 'H 427-3'	10	18	23	0.4	13	11	14	0.1	5	12	14	0.1	5	16	22	0.4

poplar clones for investigating their site requirements, growing patterns and yield. The trial discussed in this paper was allocated in subcomparment Szentkirály 40G in the Danube–Tisza interflow region (in central part of Hungary) in spring 1988, with the following clones (artificial hybrids):

- 'H 427-3' (*Populus alba x Populus alba cv.* Bolleana),
- 'H 758' (*Populus alba* Mosonmagyaróvár 124),
- 'H 425-4' (*Populus alba x Populus alba*),
- 'H 422-9' (*Populus alba x Populus grandidentata*),
- control (common white poplar).

The experiment was set up in a randomised block system with three replications. The initial spacing was 2.0 x 2.0 m. The control white poplar and the third replication of the clones, due to the unfavourable site conditions, died out at the age of 2. Because of this the characteristics of the main part of a white poplar stand of Yield Class I (Yield table: Rédei, 1991) was considered as control with the following values: mean height = 21.4 m; mean DBH = 24.5 cm; mean tree volume (according to the volume table for white poplar) = 0.501 m^3/tree at the age of 20.

According to the Hungarian classification of forest site types, the main ecological characteristics of the study area are the following:

- forest steppe climate zone: humidity is less than 50% in July at 2 pm, the annual precipitation is less than 500 mm,
- hydrology: free draining,
- genetic soil type: humid sand soil with very shallow rootable depth (< 20 cm) with 0.1% of total salt content.

Assessment of tree and stand characteristics

The following stand parameters were measured and calculated at the age of 5, 10, 15 and 20 years: stem number, dbh.(diameter at breast height), basal area, tree height, stem volume, stand volume and mean tree volume. Stem volume was estimated by the following volume function (*Sopp, 1974*):

$$v=d^2*(h^{(p_o+1)})*(p_1*d*h+p_2*d+p_3*h+p_4)/(((h-1.3)^{p_o})*10^8),$$

where d is diameter at breast height ($d_{1.3}$, cm), h is tree height (m), $p_o= 2$, $p_1= -4236$, $p_2=12.43$, $p_3=4.6$, $p_4=3298$.

Tree quality classification

To characterize tree quality, the *stem quality index* at the age of 20 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 was calculated as the average of the stem classes weighted by stem number.

Results

Some yield data and the relevant percentage-values compared to the control calculated on the basis of replications' means at the age of 20 can be found in *Table 2*.

Table 2 Yield data of white poplar clones at the age of 20 (replications' means)

Name of clones	Mean height m	(%)	Mean dbh cm	(%)	Mean tree volume m^3	(%)	Stem quality index
'H 427-3'	19.6	92	18.1	74	0.259	52	1.6
'H 758'	20.3	95	22.2	99	0.402	80	1.5
'H 425-4'	22.6	106	25.6	104	0.542	108	1.3
'H 422-9'	18.8	88	17.9	73	0.244	49	1.8
Control*	21.4	100	24.5	100	0.501	100	–

** data derived from yield table (Rédei, 1991)*

On the basis of the data, considering the growth in height, and mean dbh, the clone 'H 425-4' provided the best result. It overpassed the control by 6 and 4 per cent, respectively. The tendency is the same with regard to the mean tree volume values. The effect of differences in dbh on the mean tree values seems to be considerable (additional 8 per cent for the above-mentioned clone). As the stem quality index is concerned, the succession from best to worst is: 'H 425-4', 'H 758' 'H 427-3' and 'H 422-9'.

For a simple evaluation, mean tree volume (v, m^3) was defined in function of dbh (cm) by the following way:

$v = b_0+b_1dbh+b_2dbh^2$, where $b_0 = -0.1610$, $b_1 = 0.0119$ and $b_2 = 6,1048^{-04}$.

Then we can calculate the total volume per ha (V):

$V = vN$, where N = stem number per ha.

According to the significance test at P=5% level, significant differences were found in dbh ($SD_{5\%}$=7cm) and in the mean tree volume values ($SD_{5\%} = 0.144$ m^3).

The trees in the clone trial, as it was mentioned above, thrive under marginal site conditions that are normally unfavourable for poplar growing. Considering this fact, the early evaluation showed that all the examined white poplar clones are promising for growing on the above-described sites. The clones 'H 425-4' and 'H 758' seem to be suitable for wood production, while the 'H 427-3' and 'H 422-9' ones (with decorative stem form) could be better used for tree lines and ornamental plantations. The clone marked 'H 425-4' has been registered as cultivar-candidate.

Conclusions

As the results suggest, systematic testing is essential in poplar breeding. However, results with smaller probability of error can only be achieved after a long period of research. The systematic evaluations of clone 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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