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Clonal selection of black locust (*Robinia pseudoacacia* L.) in Hungary: a review

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Summary: Black locust (*Robinia pseudoacacia* L.) is the most important fast growing stand-forming tree species in Hungary. Its importance is increasing in many other countries, too. As a result of a new selection programme 13 black locust clones have been improved for setting up clones trials and seed orchard. In 2003 five of them (*R.p.* 'Bácska', 'Homoki', 'Szálas', 'Oszlopos' and 'Vacsi') were registered as cultivar-candidates. Tissue culture method has proved as a suitable mean of propagating superior individuals. The micropropagated plants have been growing successfully in the clone trials.

Key words: *Robinia pseudoacacia* L., micropropagation, selection, clone trials

Introduction

Black locust (*Robinia pseudoacacia* L.) is native to the mountains of the eastern United States and naturalized throughout much of the North America as well as many parts of the world. It was the first tree species to be introduced from Noth America to Europe. Its rapid spread all over the world may be attributed to its adaptability to a wide range of conditions, favourable breading properties, excellent coppicing, high surrival rates, fast growth and high yield.

The first afforestation using this species was carried out by the military administration in 1750 around the fort of Herkály near Komárom. The first large black locust plantations were established at the beginning of the 19th century on the Great Hungarian Plain for stabilizing the wind-blown sandy. Then, owing to the results achieved, black locust was spread all over the country, and at present is the most widely used species in afforestation in Hungary, covering 22% (400 000 ha) of the country's total forest area (*Führer & Rédei*, 2003).

Black locust timber can be used by industry (mining, construction, furniture, building industry and floor covering) by agriculture (post, pole wood and agricultural timber) and the black locust stands are the basis of the Hungarian apiculture and honey production. The black locust is also one of the most suitable tree species for establishing energy and environmental plantations. The development of an integrated landscape includes forests, agricultural fields and shelterbelts. In these cases afforestation with black locust is focused on improving the natural environment and the living conditions of the population as well.

The most important black locust growing regions in Hungary are located in south and south-west Transdanubia (hill-ridges of Vas-Zala county, hill-ridges Somogy county), the Danube-Tisza Interfluve (central Hungary) and north-east Hungary (Nyirség region) (*Figure1*).

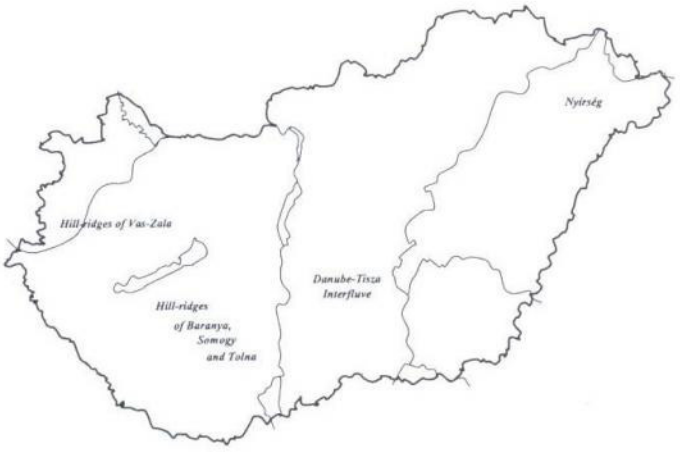

Figure 1 The main growing regions of black locust (*Robinia pseudoacacia* L.) stands in Hungary

The black locust stands of Yield Class I–II have a rotation of 35–40 years and an annual increment of total volume of 12–14 m^3/ha/yr (*Rédei,* 1998). The stands of Yield Class III–IV have a rotation of 30 years and an annual increment of 8–9 m^3/ha/yr. Finally, the poorest stands (Yield Class V–VI) have a rotation of 20–25 years and an annual increment of 4–6 m^3/ha/yr. In first generation coppice stands, growing stock, increment and health are similar to those in high forests.

On global basis, the black locust has been extensively planted in some Asian countries (Turkey, China, Korea) for various purposes, such as fuel, forage, honey production, soil erosion control, windbreak and landscape (*Keresztesi,* 1988).Recently, the usefulness of black locust in timber production and agriculture has been recognized by European

and South-American countries as well, which has promoted new introduction and research on black locust.

Short review on history of breeding and selection of black locust in Hungary

Breeding and selection of black locust was initiated in Hungary by one of the leading plant breeders, *R.Fleischmann*. He started selection of superior (plus) trees in 1930, but his experiments perished during the World War II. A new breeding programme was started again in the 1950's in the Hungarian Forest Research Institute (FRI). The aim of the work was defined in accordance with Fleischmann's ideas, as follows on one hand, selection of fast growing plus trees with straight stems, resistant to frost, on the other hand, prolongation of the flowering period and the increase of is nectar yield. Seventy five plus trees were selected in various forest regions of the country. A clone bank and clonal tests with indigenous plus tree grafts were established in the Bajti nursery of the Experiment Station of FRI at Sárvár and Gödöllő Arborétum. Breeding materials received from foreign research institutes were also included in order to investigate and test the clones.

Comparative clone and cultivar trials were established in 1964 on rusty brown forest soil at Gödöllő Arboretum of FRI. The objective of these trials was to compare the performance of cultivars from the Hungarian collection and abroad for growth and other important traits. Trials were carried out according to guidelines on establishing and tending black locust stands (*Keresztesi*, 1988).

In the beginning, the propagation of the cultivars was carried out by grafting, and later by cuttings. Seedlings were raised from the registered seed stand of common black locust (*R p. var. vulgaris*) grown in the Nyírség sandy region and in sandy ridges between the rivers of Danube and Tisza served as control.

During the last 40 years mono- and multiclonal cultivars were developed and a seed orchard was established from the selections. According to the basic selection goal, cultivars can be classified into three groups (bold letters indicate the cultivars with a state-approved status in 2005):

1. Production of logs suitable for sawmilling (target product: sawlogs). The best cultivars are: ***'Nyírségi'***, ***'Kiskunsági'***, ***'Jászkiséri'***, ***'Üllői'***, ***'Appalachia'***, *'Pénzesdombi'*, *'Röjtökmuzsaji'* and *'Góri'*.
2. Production of poles and props (pitprops, vine and orchard props, fence poles, hop poles). Best cultivars: ***'Zalai'***, *'Császartöltési'*, *'Szajki'* and *'Váti-46'*.
3. Improvement of bee pastures and decorative characteristics. Best cultivars: ***'Rózsaszin-AC'***, *'Mátyusi 1–3'*.

Some cultivars are suitable for both wood and honey production. Such double-use cultivars are: *'Zalai'*, *'Kiskunsági'*, *'Császártöltési'*, *'Egylevelű'* and *'Váti-46'*.

The examinations on stand structure and yield of the improved black locust cultivars were started at 1964 on experimental plots established in the Arboreta of FRI at Gödöllő. In order to describe the growth of the cultivars suitable for sawlog production (*'Nyírségi'*, *'Kiskunsági'*, *'Jászkiséri'*, *'Appalachia'*, *'Egylevelű'*) detailed inventories were carried out each year until the stands reached the tenth year of age, then that were only carried out in every fifth year in 15 experimental plots.

Based on the stand-structure factors' investigations an equation has been developed to predict the volume of main crop per ha (V_{mc}) (*Lessényi & Rédei*, 1986):

$$V_{mc}(m^3/ha) = 23{,}750\text{-}2{,}325\ H_{mc}+0{,}515\ H^2_{mc},$$

where H_{mc} is height of the main crop (m).

A comparison between the production of common black locust (Yield table: *Rédei*, 1984) and the production of the examined five cultivars can be seen in *Table 1*.

Table 1 The volume of the main crop of black locust cultivars at the age of 30 and 35 (m^3/ha)

Age year)	Black locust cultivars			Common black locust		
	Yield class			Yield class		
	I.	II.	III.	I.	II.	III.
30	286	242	202	281	233	189
35	311	263	219	314	265	212

According to the *Table 1* there is no significant difference in volume of the main crop between the cultivars and the common black locust at the planned final cutting age (30–35 years) in stands of I–III yield classes. The average deviation is 3,5% for the cultivars, which is indelible difference from wood production point of view. Under poorer site conditions (V–VI yield classes) it is not possible to manage plantations profitably established with selected black locust cultivars.

A partly new selection programme for black locust

In Hungary the range of sites optimal for black locust growing is rather limited. Therefore, black locust growing is exercised often on sub-optimal sites. Possibilities for black locust growing are highly influenced by climatic conditions and extremes (temperature and precipitation), water supply and unfavourable soil conditions. In the lowlands, which are the most suitable regions for black locust management, annual precipitation is not more than 500–550 mm, most of which is outside the growing season. In the summer period drought is a frequently phenomenon, coupled with very high air temperatures (30–35 °C). Relative air humidity in July is usually between 20–50%. Due to the filling up of basin-like lowlands in Hungary, site conditions are mosaic, which changes even over small distances, causing widely differing growth potential for black locust plantations. For this reason, there are no large, contiguous areas of homogenous site quality for black locust, and its growth and productivity may be very variable within a large field. Therefore, the main aim of the new selection work coordinated by *K. Rédei* was to

Table 2 Some parameters of planted-out micropropagated clonal material at age of 5 at Kecskemét

Clones	Plot number	Height (m)	Plant survival (%)	Height (plot average) (m)	Plant survival (plot average) (%)
Pusztavacs 233 A/1 *('PV 233 A/1')*	19	5.9	44	6.7	63
	28	7.1	75		
	36	7.1	69		
Pusztavacs 201 E 2/4 *('PV 201 E 2/4')*	20	6.4	94	6.7	71
	29	8.0	63		
	37	5.7	56		
Pusztavacs 201 E 2/1 *('PV 201 E 2/1')*	21	6.4	100	7.3	88
	30	8.0	63		
	40	7.4	100		
Mikebuda 15 A 2/3 *('MB 15 A 2/3')*	22	7.3	81	6.5	67
	38	6.4	56		
	39	5.9	63		
Pusztavacs 201 E 2/3 *('PV 201 E 2/3')*	23	7.1	63	7.5	81
	31	7.5	81		
	41	7.9	100		
Pusztavacs 35 B/2 *('PV 35 B/2')*	24	6.2	69	6.8	79
	32	7.5	75		
	42	6.8	94		
Mikebuda 17 D 3/10 *('MB 17 D 3/10')*	25	7.9	75	7.7	83
	33	7.6	81		
	43	7.5	94		
Mikebuda 17 D ? *('MB 17 D 3/4')*	26	8.0	44	8.2	61
	34	9.0	63		
	44	7.5	75		
Common black locust	27	6.9	63	7.1	79
	35	8.1	81		
	45	6.3	94		

find and improve black locust clones, which perform good shape; provide good-quality wood material for industrial purposes and which can adapt to the changed ecological conditions as well.

As a result of the new selection programme 13 black locust clones (*'KH 56A 2/6', 'MB 12D', 'MB 17D 4/1', 'CST 61A 3/1', 'MB 15A 2/3', 'MB 17D 3/10', 'PV 201E 2/1', 'PV 201E 2/3', 'PV 201E 2/4', 'PV 35B/2', and 'PV 233A/1'*) have been improved over the last few years cooperating with the Micropropagation Laboratory of Research Institute for Fruit Growing and Ornamentals. In 2003 five of them (*R.p.* 'Bácska', 'Homoki', 'Szálas', 'Oszlopos' and 'Vacsi') were registered as cultivar-candidates.

The first clone trial using micropropagated plants was established near Kecskemét (Central-Hungary) in spring 2002.

The main ecological conditions of the study area are as follows:

- relative air humidity below 50%,
- hydrology: free draining,
- genetic soil type: humous sand soil,
- annual precipitation is less than 550 mm (between April 1 and 26 September in 2002 the precipitation was 188 mm).

At the end of the fifth growing season micropropagated plants attained a height of 6.5–8.2 m. Reasonable field survival rates were achieved (*Table 2*). Clonal material regenerated from the same tree showed uniformity in the stem form. Higher variability occurred in height growth of individual trees planted in the field. It seems that nonuniformity in rooting and development as well as in number of roots can strongly affect the growth of micropropagated plants.

Conclusions

Experiments with black locust have shown that it is a tree species with great regenerative potential from tissue culture. This method can be used effectively for black locust selection programmes. Therefore, its application is recommended for meeting the qualitative requirements of propagation material as well. Experiments have demonstrated that micropropagated plants can be successfully transplanted into soil, hardened and grown in the field. On base of these research results a black locust seed orchard (Pilis) and a seed production stand (Kecskemét-Helvécia) has also been set up.

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