Promising black locust (*Robinia pseudoacacia* L.) cultivars in Hungary

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Summary: In Hungary, black locust (*Robinia pseudoacacia* L.) is one of the most important exotic stand-forming tree species, growing mostly under unfavourable ecological conditions. Considering the climate change effects its importance is increasing in many other countries. As a result of a selection programme, several black locust cultivars have been improved for setting up cultivar trials. In the paper four black locust cultivars were evaluated in Central Hungary under arid hydrological and brown forest soil conditions. Significant differences (P<5%) were found in height, DBH, mean tree volume and average stem form value (SFV). At the age of 35 the cultivar 'R.p. Jászkiséri' appeared to be the most promising one for yield production and 'R.p. Zalai' for SFV.

Introduction

Black locust *(Robinia pseudoacacia* L.) is a species native to North America that has a long tradition of uses as an ornamental, forest tree, street tree, and is also favoured by beekeepers. The tree is naturalised in many parts of the world including Asia, Africa and several countries in Europe. Black locust is an early successional species readily colonising open grounds, but not regenerating in the shade, usually out-competed by longer living hardwoods in the course of succession.

Since the introduction of black locust into Hungary this tree species has been closely associated with agriculture, and its wood could be utilized for many agricultural and domestic purposes. After World War II its importance changed, because large-scale farms had lower demand for wood and the timber industry was not willing to buy black locust wood. It was necessary to improve the quality of final products of black locust forests to meet the demands of consumers. Therefore, new cultivars had to be produced by selection techniques and had to be introduced into the practical forestry use (Keresztesi, 1988).

The strategy aimed to improve the quality of black locust stands, which were considered to be separate provenances. In the best black locust stands tree groups of shipmast stem form, then plus trees were selected by B. Keresztesi and his colleagues (Keresztesi, 1988). The offsprings of these selected trees were propagated in a vegetative way (root cuttings) and were grouped together into varieties. Thus, varieties are mostly composed of several clones, but there are also some one-clone-varieties.

Propagation of cultivars was first planned by seedlings, but the seed orchards produced small quantities of seed. So, it was necessary to develop techniques for vegetative propagation (with green cuttings, root cuttings and micropropagation) (Rédei et al., 2002).

At present research is being done partly by international cooperation to find the genetic background of quantitative and qualitative features of varieties of several clones. Clone identification markers are determined for this work at protein and DNS levels. The long-term aim is the investigation of the linkage between quantitative features and selected markers, as well as the determination of genetic factors responsible for quantitative features (Rédei et al., 2008).

Besides Hungary, black locust breeding and improvement is undertaken in the United States (Chalupa et al. 1992), Greece (Dini-Papanastasi & Panetsos, 2000), Germany (Liesebach et al., 2004; Böhm et al., 2011), Slovakia (Chalupa, 1992), Poland (Kraszkiewicz, 2013), Bulgaria, Turkey (Dengiz et al., 2010), India (Sharma, 2000), China (Dunlun et al., 1995) and South Korea (Lee et al., 2007).

Materials and methods

Study site

Data used in this study came from a black locust clone trial established in the forest sub-compartment located at Gödöllő 5G, central Hungary (E19^{0}22', N47^{0}36,) *(Figure 1)*. It has brown forest soil without groundwater influence. The annual precipitation amounts to only 500-550 mm in some years, of which less than 350 mm comes in the dry summer period.
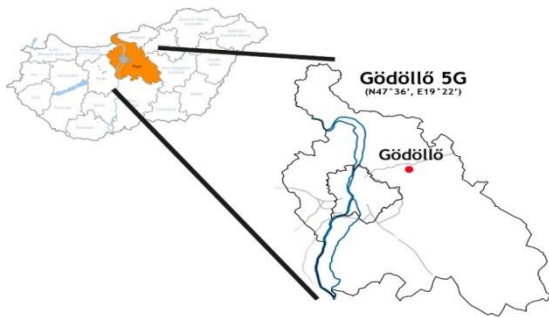
Figure 1. Location of the study site

Materials

The trial, with three replications was established at a spacing of 2.0 m × 1.0 m. Rooted cuttings of four black locust cultivars, i.e. 'R.p. 'Zalai', R.p. 'Kiskunsági', R.p. 'Nyírségi', R.p. 'Jászkiséri' as well as common black locust as a control were planted. Common black locust plants were produced by seeds. Each treatment corresponds to a plot of 20 by 25 m. A random block was designed where each block included all the different treatments (cultivars) once.

Methods

The following parameters were measured and calculated at the age of 35 years: number of stems, tree height, DBH (diameter at breast height) over bark, stem volume and mean tree volume. The stem volume was calculated using the following function based on the volume table for black locust (Kolozs – Sopp, 2000): $v = 10^{-8}d^2h^1(h/[h-1.3])^2(-0.6326dbh+20.23d+3034)$, where v is stem volume (m^3), dbh is diameter at breast height (cm), h is tree height (m). The mean tree volume ($\bar{v}$, m^3 per tree) was calculated using the means of stem volume (h, dbh) for each of the experimental plots (Rédei, 2002).

The stem form classes used by us are as follows at the age of final harvesting: 1) Straight, cylindrical, healthy stems, reaching to the top of the crown. Crooks are tolerated in one dimension only, not more than twice the stem diameter (x_1). 2) The stem is straight, forks are tolerated, but only if they are in the uppermost third of the tree. Crooks are tolerated in one dimension only, not more than three times the stem diameter (x_2). 3) The stem is crooked and leaning. Crooks may reach five times the stem diameter in one dimension and minor crookedness in a second dimension is tolerated (x_3). 4) Very crooked in more than one dimension, low branching, forked trees with stem defects, broken crown or stem rot (x_4) (Rédei et al., 2012).

The average stem form value (SFV) was determined on base of the following formula:

$$SFV = \frac{x_1 n_1 + x_2 n_2 + x_3 n_3 + x_4 n_4}{n_1 + n_2 + n_3 + n_4}$$

where $x_1, x_2, x_3, x_4 =$ stem form classes, $n_1, n_2, n_3, n_4 =$ tree numbers belonging to the single tree quality classes.

The data were analysed by IBM SPSS 22.0 statistical software package. Analysis of variance (one-way ANOVA) was done for height, dbh, mean tree volume and stem form to consider the trial with having completely randomized design.

Results

Table 1 illustrates the most important stand structure parameters (h, DBH, $\bar{v}$) and the stem form values (SFV) at the age of 35 years and *Table 2*, illustrates the statistical analysis of them. A comparison of mean height and mean DBH illustrated that the cultivar 'R.p.Jászkiséri' reached the highest value *(Figure 2)*. The same result was obtained in mean tree volume ($\bar{v}$) *(Figure 2)*, cultivar 'R.p. Zalai' had the best SFV *(Figure 3)*. $SD_{5\%}$ values in case of height = 1.36m, of DBH = 1.27cm, of $\bar{v}$ = 0.066 m^3 and of SFV = 0.179.

Table 1. Stand characteristics of black locust cultivars at the age of 35 years

Cultivar name	Height (m)	DBH (cm)	Mean tree volume ($\bar{v}$) (m^3)	SFV (1-4)
R.p.'Zalai' (1)	20.4	19.3	0.309	1.080
	21.0	20.9	0.369	1.222
	21.0	19.6	0.326	1.070
R.p.'Kiskunsági' (2)	21.8	23.0	0.461	1.351
	23.2	23.6	0.510	1.177
	22.8	22.6	0.488	1.060
R.p. 'Nyírségi' (3)	22.0	21.6	0.410	1.205
	19.4	20.6	0.341	1.140
	20.4	22.0	0.401	1.145
R.p. 'Jászkiséri' (4)	23.8	26.7	0.667	1.241
	23.0	26.9	0.663	1.340
	23.4	26.8	0.665	1.290
Common black lotust (control) (5)	20.7	25.6	0.551	2.370
	21.7	22.4	0.439	2.623
	21.3	23.4	0.470	2.485

Table 2. The least significant difference test ($LSD_{0.05}$) of the most important parameters of stand structure at the age of 35 years

Cultivar name	Height (m)	DBH (cm)	Mean tree volume ($\bar{v}$) (m^3)	SFV
"R. p. Zalai"	20.8c	19.9d	0.335c	1.12b
"R. p. Kiskunsági"	22.6ab	23.1bc	0.486b	1.20b
"R. p. Nyírségi"	20.6c	21.4cd	0.384c	1.16b
"R. p. Jászkiséri"	23.4a	26.8a	0.665a	1.29b
Common black locust (control)	21.2bc	23.8bc	0.487b	2.49a

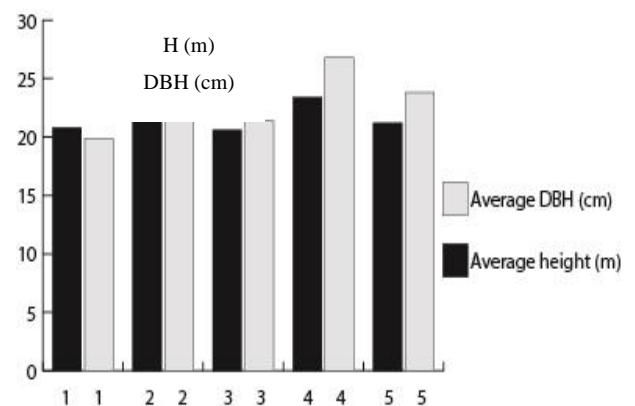R. p. – *Robinia pseudoacacia* L., SFV – stem from value

Figure 2. H and DBH data of 35-year-old black locust cultivars as a mean of plots
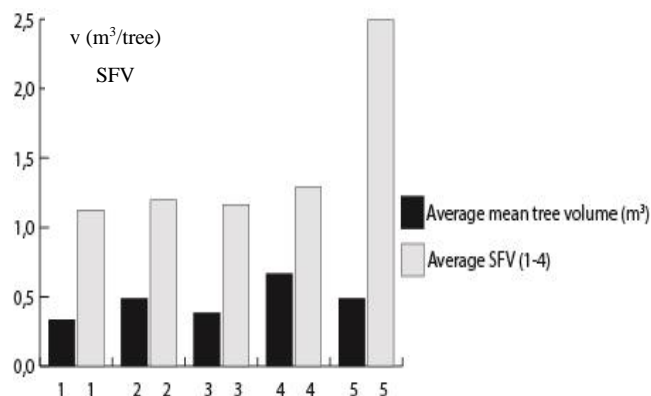
Figure 3. Average mean tree volume (v⁻) and SFV data of 35-year-old black locust cultivars as a mean of plots

Discussion

This study leads to the following conclusions: (1) the growth and yield data at the end of the 35th growing season demonstrated that the selected black locust cultivars can be grown successfully under semi-marginal site conditions; (2) vegetative propagation method - rooted cuttings - has proved as a suitable means in the field of black locust clonal selection; (3) by growing selected black locust cultivars it is possible to increase significantly the stem quality and in such a way to increase the ratio of wood material using for industrial purposes (by 25-30 % on average; (4) application of genetic improvement may remove several hindrances to the widespread use of black locust in some, potentially promising countries from black locust growing point of view.

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