

## **Short Communications**



## **Black Locust (*Robinia pseudoacacia* L.) Improvement in Hungary: a Review**

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**Abstract** – Black locust (*Robinia pseudoacacia* L.) was the first forest tree species introduced and acclimated from North America to Europe at the beginning of the 17th century. It is a fast growing, nitrogen fixing, site tolerant, excellent coppicing species with frequent and abundant seed production and relatively high yielding potential. It has a durable and high quality wood, which is used for many purposes. Although native of North America, black locust is now naturalized and widely planted throughout the world from temperate to subtropical areas. In Hungary, this species has played a role of great importance in the forest management, covering approximately 23% of the forested area and providing about 19% of the annual timber output of the country. Due to the increasing interest in black locust growing in many countries, this study has been compiled with the aim of giving a summary on the basis of research and improvement connected with the species over the past decades.

**Black locust (*Robinia pseudoacacia* L.) / clone selection / silviculture / yield / energy plantations**

**Kivonat** – **Áttekintés a magyarországi akácnevelésről.** A fehér akác (*Robinia pseudoacacia* L.) az első észak-amerikai erdei fafaj volt, amely, alkalmazkodva a klimatikus feltételekhez, a XVII. század elején meghonosodott Európában. Gyorsan növő, nitrogén-megkötő, termőhelytűrő, könnyen sarjadó fafaj, gyakori és bőséges magterméssel és viszonylag jó fatermőképességgel. Tartós, jó minőségű fája számos célra felhasználható. Bár Észak-Amerikában őshonos, mára elterjedt és széleskörűen telepíthető az egész világon a mérsékelt éghajlatútól a szubtropikus területekig. Magyarországon fontos szerepet játszik az erdőgazdálkodásban, az erdőszült terület mintegy 23%-át borítja, és az ország éves fakitermelésének 19%-át teszi ki. Tanulmányunkat a fafaj termesztése iránti megnövekedett érdeklődés kapcsán, összefoglalás céljából állítottuk össze az elmúlt évtizedek kutatási eredményei alapján.

**Fehér akác (*Robinia pseudoacacia* L.) / klónszelekció / erdőművelés / fatermés / energetikai faültetvények**

### **1 INTRODUCTION**

Black locust was introduced in Hungary between 1710 and 1720. The first large black locust forests were established at the beginning of the 19<sup>th</sup> century on the Great Hungarian Plain stabilizing the wind-blown sandy soil. In the country, black locust occupied 37.000 ha in

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1885, 109.000 ha in 1911, 186.000 ha in 1938 and 4.000.000 ha in 2005. At present, it is the most widely planted species in Hungary, covering 23% of the country's total forest area. One-third of these stands are high forests and two-third of them are of coppice origin. In the 1960s, Hungary had more black locust forests than the rest of European countries together.

Black locust forests in Hungary have been established on good as well as on medium and poor quality sites. Establishment of black locust stands producing timber of good quality is possible only on sites with adequate moisture and well-aerated and preferably light soils, rich in nutrients and humus. Black locust forests on medium and poor quality sites are utilized for the production of fuel wood, fodder, poles and props, as well as for honey production, soil protection and environmental improvement.

The most important black locust growing regions in Hungary are located in the south and south-west Transdanubia (hill-ridges of Vas-Zala county, hill-ridges Somogy county), the plain between the rivers Danube and Tisza (Central Hungary) and north-east Hungary (Nyírség region).

## 2 IMPROVEMENT OF BLACK LOCUST STANDS IN HUNGARY

### 2.1 Clone and cultivar selection

In Hungary, the main goals of the first black locust breeding programme (in the 1960's) were to select new clones and cultivars providing good quality and volume of industrial wood. Superior tree groups have been identified in some seed grown stands. Graft material was taken from the plus trees and planted in test plots at Gödöllő (experimental station of FRI). *Mono- and multiclonal cultivars* were developed and a seed orchard was established from the selections. The Hungarian Forest Research Institute coordinated this research programme. With respect to the volume expected at felling age, the '*Jászkiséri*', '*Kiscsalai*', '*Nyírségi*', '*Üllői*' and '*Szajki*' cultivars proved to be the best (Keresztesi 1988)

In Hungary, the range of sites optimal for black locust growing is rather limited. Therefore, black locust growing is often exercised 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 growing, the annual precipitation is not more than 500-550 mm, most of which is outside the growing season. Thus drought is a frequent phenomenon in the summer period coupled with very high atmospheric 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 show a mosaic pattern, which changes even over small distances causing widely differentiated growth potential for black locust plantations. For this reason, there are no large, contiguous lands of homogenous site quality for black locust, and their growth and productivity may be very different across a large field. Therefore, the main aim of our new selection work is to find and improve black locust clones and cultivars, which perform good shape, provide good-quality wood material for industrial purposes, and which are able to tolerate the changing ecological conditions as well. As a result of our new selection programme 12 black locust clones ('KH 56A 2/5', '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 35 B/2', and 'PV 233 A/2') have been recommended (Rédei et al. 2002, Rédei 2003).

## 2.2 Propagation

In Hungary, black locust plants are commonly multiplied by two methods: by seed and by root cuttings. Growing trees from *seed* is a relatively simple method for reliably producing seedlings on a large scale under a variety of circumstances. There are two state approved seed production stand-regions meeting the requirements for black locust seeds (one in the plain between the rivers Danube and Tisza and the other in the Nyírség region). Seeds are collected by sieving the top 20 cm of soil beneath the selected seed-producing stands. As the seeds of black locust used to remain dormant in the soil for several years, the age of seeds within the lots collected in this way is very variable. This is the reason of viability and germination are so variable. Therefore, before sowing, an accurate seed test is necessary. Seed production for sowing and scarification is carried out by the agency responsible for collecting the seed. It is advisable to treat the seeds against fungi, and this is done in a small concrete mixer. 200-250 thousand seedlings of 40-90 cm high and 5-12 mm in base diameter are raised on one hectare. Mechanization of the method is easy and the production costs are relatively low.

Propagation from root cuttings is suitable for reproduction of superior individuals or varieties (cultivars). By applying this method, superior traits of the selected trees can be preserved in the clones. Production of plants in this way demands more care than raising seedlings from seeds. For this propagation method, root pieces cut into 8–10 cm or chopped to 3-5 cm in length are used. Plant spacing in the rows should be 5-8 cm.

Almost 25 new cultivars or selected clones were micro-propagated during the last few years in the Micro-propagation Laboratory of Research Institute for Fruit growing and Ornamentals, Érd in collaboration with the Hungarian Forest Research Institute. Plant tissue culture methods provide us with new means to speed up vegetative propagation of recently selected clones and give us the opportunity to establish new clone trials and a seed orchard with them.

## 2.3 Stand establishment, forest tending and yield

Climate, hydrology and genetic soil types are the factors that determine the site type, and this in turn determines the choice of tree species. The water regime of the soil is also highly influenced by the texture of the soil, whether it is humus, coarse sand, loam or clay. Black locust – because of its high requirement for both water and aeration in the soil – cannot be grown even on any soil composed of humus, coarse sand or clay if the rooting depth is very shallow.

Black locust requires well-drained soils with adequate moisture until the associated nitrogen-fixing *Rhizobium* bacteria are able to thrive. That is why soil preparation (total or partial) to improve aeration and the water regime of the soil and tilling of the inter-row space may become necessary.

Black locust afforestation and artificial regeneration may utilise seedlings. The most popular spacing for black locust in Hungary is 2.4 m by 0.7 to 1.0 m, requiring at least 4000 seedlings/ha. Black locust stands are often regenerated by coppice (from root suckers) as well. In young stands of coppice origin, a cleaning operation should be carried out to adjust spacing when the stands are 3-6 years old and should reduce stocking to less than 5000 stems/ha.

The black locust is a fast-growing tree species, which, up to the age of 10-15 years, is able to close canopy openings caused by tending operations quickly, but the closure is much slower in later years. Height growth peaks within the first five years, while diameter growth culminates in the first decade. The peak of current annual increment is at about the age of 20, whereas that of the mean annual increment is at about the age of 35-40 years.

To find the right cleaning and thinning intensity, the so-called growing space index is a good method. This index expresses the mean distance between trees (in a triangular pattern)

as a percentage of mean height after cleaning and thinning. The mean value of the index for black locust stands should be 23-24%. Pruning of crop trees should also be carried out. After finishing selective thinning, stems must be free of branches up to a height of 4-6 m.

The objective of tending is to produce a high proportion of good quality saw-logs from stands of yield class I and II; some saw-logs and a high proportion of poles and props from stands of yield class III and IV; and poles, props and other small-dimension industrial wood from other yield stands.

According to our yield table (Rédei 1984) the volume of main crop varies between 80 and 280 m<sup>3</sup>/ha in function of yield classes at the age of 30 years, which is the average rotation age for black locust 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<sup>3</sup>/ha/yr. The stands of Yield Class III–IV have a rotation of 30 years and an annual increment of 8-9 m<sup>3</sup>/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<sup>3</sup>/ha/yr. In first generation coppice stands, growing stock, increment and health are similar to those in high forests.

## 2.4 Black locust energy plantations

More and more agricultural land is being taken out of use for food crops, some of which can be used for wood energy production plantations. Black locust is the very best tree species for this purpose, since it has excellent energy production properties, such as:

- vigorous growing potential in juvenile phase,
- excellent coppicing ability,
- high density of the wood,
- high dry matter production,
- favourable combustibility of the wood,
- relatively fast drying,
- easy harvesting and wood processing.

In the last decade several energy producing plantations have been established in Hungary. In these experiments, several spacing treatments were tested and the common black locust as well as its cultivars were compared.

In Helvécia (central Hungary, sand-soil region) an energy plantation was established using common black locust and its cultivars. The various spacings of the common black locust were: 1.5x0.3 m, 1.5x0.5 m and 1.5x1.0 m. At the age of 5 years the closest spacing (1.5x0.3 m) produced the greatest annual increment in oven-dry mass (6.5 t/ha/yr). This exceeded the increments of the two wider spacings by 33% and 51%, respectively. According to the results of the yield trial with black locust cultivars planted at 1.5x1.0 m spacing, at 5 years the highest yield was produced by the cultivar 'Üllői' (8.0 t/ha/yr), followed by 'Jászkiséri' (7.3 t/ha/yr) and the common black locust (6.7 t/ha/yr).

Black locust energy forests can also be established by coppicing. Advantages of energy forests of coppice origin are that the cost of establishment is low compared to that of soil preparation, plantation and cultivation. From the developed root system of the previous stand, a large dendromass can be produced within a short time period. Disadvantages of these forests are that the area distribution of trees in coppice stands is not as uniform as in plantations optimized for energy production. In coppice stands the quantity of the produced dendromass is lower and the length of growing time is highly influenced by the uneven distribution of stems.

The first peak of the annual increment in volume of black locust energy forests established from sprouts falls between the age of 3 and 5 years. Then, the annual increment declines and a new peak occurs between age of 9 and 12 years. A further maximum is

expected later on, at about 15 years because of an even higher degree of mortality. Approximately one-third of the stems are lost at age 7 and 8. By the 12-13 years, the stem numbers decreased to less than 50%.

The experiences from both the planted and the coppiced energy plantations and other stands indicate that it is not reasonable to harvest in the first three years, as the yield in oven-dry weight in the fifth year is 2-3 times higher than it is in the fourth year. Harvesting too early may also increase the population of biotic pests.

### 3 CONCLUSION

Black locust was the first forest tree species introduced from North America to Europe. Hungary has got much experience in black locust growing, as it has been grown for more than 250 years in the country. Being aware of the importance of black locust, forest research in Hungary has been engaged in resolving various problems of black locust management for a long time, and a lot of research results have already been implemented in the practice.

In the future there are two bigger regions, where the fast spread of black locust can be expected. In Europe the Mediterranean countries (Italy, Greece, Spain and Turkey), while in Asia China and Korea may become the most prominent black locust growers.

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## Guide for Authors

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Acta Silvatica et Lignaria Hungarica publishes original reports and reviews in the field of forest, wood and environmental sciences. Submission of an article implies that the work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere. Articles should be written either in English or in German. All papers will be proofread by two independent experts.

Authors of papers accepted for publication should sign the Publishing Agreement that can be downloaded from the homepage (<http://aslh.nyme.hu>)

For the first submission three hardcopies, for the final submission a single hardcopy of the paper should be sent by mail to the ASLH Editorial Office (University of West Hungary, Pf. 132, H-9401 Sopron, Hungary). The manuscript should also be sent on a floppy or via e-mail ([aslh@nyme.hu](mailto:aslh@nyme.hu)). The text should be formatted in MS Word

Please also include all figures and tables as separate files in the form they were originally created in (e.g. MS Excel, Word, JPG). Save your files using the default extension of the program used.

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Manuscripts should be prepared on A4 International (210 by 297 mm) in single column format. Set the margins at 2.5 cm. Use 12 pitch Times New Roman or similar as the font. The final layout of the text should be single-spaced (except for the first submission, before proofreading, when it should be double-spaced throughout, i.e. also for abstracts, footnotes and references). Every page of the manuscript should be numbered in the running head. However, in the text no reference should be made to page numbers. Keep the layout of the text as simple as possible. However, do use bold face, italics, subscripts, superscripts etc. but do not underline words. Do not embed 'graphically designed' equations or tables, but prepare these using the wordprocessor's facility.

Articles should not exceed 6000 words, including tables and references (and should not be longer than 16 pages including figures and graphs). They should be structured as follows (the parts in bold fonts are obligatory):

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To avoid unnecessary errors you are strongly advised to use the 'spellchecker' function of your wordprocessor. Use British English spelling throughout.

Authors whose native language is not English or German are strongly advised to have their papers checked by a native speaker before submitting it for publication.

### Layout of final submission

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Mark the corresponding author with a \* and give his/her e-mail and complete postal address in footnotes, 10 pt (\* Corresponding author: account@domain.country; H-1118 BUDAPEST, Ménesi út 44.)

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### Abstract

The paper should start with a short summary of the contents of the paper, not exceeding 160 words altogether. It is preferred that the abstract is in one single paragraph. It should give a clear idea of the main conclusions of the article, the methods employed and some indication of the line of reasoning. Use 11 pitch characters. Heading (bold face) should be run within the text e.g.

**Abstract** – The paper reports on ...

Three to six **keywords** should be included (new paragraph, 6 pt before, 11 pitch bold characters). The items should be separated by a slash (/)

After *two empty lines* the abstract and keywords should also be given in a second language (Hungarian authors should write it in Hungarian) beginning with the translated title (bold face). Use 11 pitch characters e.g.

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It should be divided into sections, each with number and section heading. Use no more than three grades of headings. – Main sections e.g. Introduction; Material studied, area descriptions, methods, techniques; Results; Discussion; Conclusion. The heading titles should be short and clearly numbered. Titles and subtitles should not be run within the text. They should be typed in a separate line, without indentation.

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Paragraphs should be justified, the first line of a new paragraph should be indented 0.75 cm. Do not separate paragraphs with one empty line.

Use italics for taxon names (*Quercus robur*) and for texts to be emphasized. Use single quotation marks ('odd use') for a specific use of an otherwise well-known term, and apply double quotation marks ("for citation") for citing text from other sources.

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Tables should be numbered consecutively. The text should include references to all tables. All appearances of such a reference should appear in italics (*Table 4*).

Each table should have a brief and self-explanatory title. The number and title of the tables should be printed in italics, before the table, left align.

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Any explanation essential to the understanding of the table should be given as a footnote at the bottom of the table.

Table 1. A sample table (A single empty line before and followed by 6 pt)

Items	1950	1950 - 1986		1986	1986-2030		2030
		Increase	Decrease		Increase	Decrease	
Item 1	xxxx		xx	xxxx	xxx		xxxx
...							
Item n	xxx	xx		xxx		xxx	xx

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Figures should be numbered according to their sequence in the text, and they should all have captions. The number and title of the figures should be printed in italics, below the figure, centred. Refer to all figures (*Figure 1*) in the text by using italics and initial capitals.

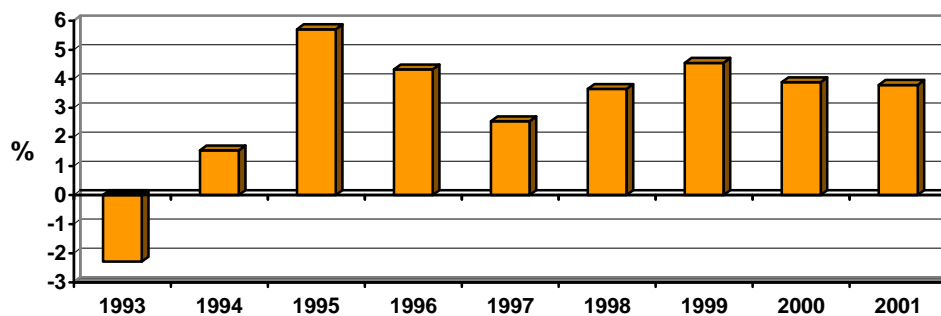


Figure 1. A sample figure

## Formulae

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- Mathematical symbols should appear in italics,  $p$ , and matrices and vectors in boldface,  $\mathbf{a}$ ,  $\mathbf{B}$ . Give the meaning of all symbols immediately after the equation in which they are first used.
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## Acknowledgements

This paragraph should appear right before the References. The text should be as short as possible. Heading (bold face) should be run within the text e.g.

**Acknowledgements:** We wish to thank ...

## References

The reference section should contain all works referred to in the text, and only those. They should be listed fully in alphabetical order of the author/editor with complete bibliographical details (including publisher and place of publication). The list of references should be arranged chronologically per author. If an author's name in the list is also mentioned with co-

authors, the following order should be used: publications of the single author, arranged according to publication dates, publications of the same author with one co-author, publications of the author with more than one co-author. Publications of the same author(s) in the same year should be listed as 1996a, 1996b, etc. The manuscript should be carefully checked to ensure that the spelling of author's names and dates are exactly the same in the text as in the reference list.

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AUTHOR, A. (1995): Book title. Publishing company, City. xx p.

BURLEY, J. – EVANS, J. – YOUNGQUIST, J. (eds.) (2004): Encyclopedia of Forest Sciences. Academic Press, London.

CODY, M. L. (1974): Competition and the structure of bird communities. Series: Monographs in Population Biology. Princeton Univ. Press. Princeton. 326 p.

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AUTHOR, D. (1984): Title of the article. In: Firsteditor, U. – Secondeditor V. (eds): Title of the book. Publishing company, City. x-xx.

TOPPINEN, A. – ADAMS, D. – MONTGOMERY, D. (2001): Biodiversity conservation and forest products in the United States Pacific Northwest. In: Palo, M. – Uusivuori, J. – Mery, G. (eds): World forests, Markets and Policies. Kluwer Academic Publishers, Dordrecht. 385-394.

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AUTHOR, B.C. (1977a): Title of the paper. Journal Vol.: x-xx.

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