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The 'Nyírségi' black locust cultivar: Growth, yield and stem quality

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Abstract: Black locust (*Robinia pseudoacacia* L.) is one of the most widespread broadleaved tree species in Hungary, accounting for approximately 24% of the forest area. Despite its rapid growth, broad site adaptability, and durable wood, poor stem quality, particularly stem crookedness and forking, often limits the production of high-quality industrial wood. To address these silvicultural drawbacks, selection breeding was initiated in the 1960s, resulting in several improved cultivars, including 'Nyírségi'. This study synthesises long-term trial data across 12 'Nyírségi' stands (aged 7–35 years) and presents a case study comparing the cultivar with seedling-origin common black locust (age: 20 years) on a marginal sandy site. The evaluated stands predominantly belonged to yield classes II to IV. While volume growth showed no statistically significant difference between genotypes, the 'Nyírségi' cultivar achieved a statistically significant 32% superiority in stem quality (2.06 vs 3.04, $P = 0.002$), alongside lower mortality (11% vs 16%) and a higher proportion of dominant crop trees. Due to the high cost of vegetative propagation, its operational use is effective mainly on high-quality sites.

Keywords: black locust improvement; growing technology; *Robinia pseudoacacia*; stand structure

Black locust (*Robinia pseudoacacia* L.), a tree species native to the southeastern regions of North America (Martin 2019; Boring, Swank 1984), has been the subject of extensive international research covering its biology, ecology, economic potential, and environmental impacts (Vítková et al. 2017; Nicolescu et al. 2018, 2020; Puchałka et al. 2021; Ábri et al. 2023). Its popularity in global vegetation restoration and short-rotation forestry stems from its rapid growth, nitrogen-fixing ability, and high-quality, decay-resistant wood (Keresztesi 1988; Yüksek, Yüksek 2011; Straker et al. 2015; Shi et al. 2021).

Following its introduction to Europe in the early 17th century, the species appeared in Hungary between 1710 and 1720. It spread rapidly due to its broad site adaptability and versatile utility – including energy production, apiculture, and soil protection – to the extent that by the 1960s, Hungary held more black locust forests than all other European countries combined (Keresztesi 1988). Although

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the species can survive on marginal sites, it performs best on fertile, well-drained, loose-textured soils (Nicolescu et al. 2018). Today, black locust accounts for approximately 24% of Hungary's forest area (Ministry of Agriculture of Hungary 2025), and although it is recognised as a significant invasive species in Europe (Vilà et al. 2009), it remains a cornerstone of the national timber supply (Ábri et al. 2023).

Black locust may exhibit, to varying degrees among individual trees, characteristics such as stem crookedness, forking, low industrial roundwood yield, and frost sensitivity, which are disadvantageous from the perspective of cultivation and production (Nicolescu et al. 2018, 2020). Research aimed at improving these traits, as well as at developing fast-growing, relatively drought-tolerant black locust cultivars, extending the flowering period, and increasing the nectar content of the flowers was initiated in the 1960s. As a result of this research, numerous black locust cultivars and candidate cultivars were selected. Among these, the cultivars 'Üllői', 'Jászkiséri', and 'Nyírségi' have been subjected to more detailed evaluation in provenance and cultivation trials (Keresztesi 1988; Ábri et al. 2021, 2023).

The vast majority of officially registered cultivars are clonal mixtures derived from 2–20 plus trees selected on the basis of phenotypic characteristics originating from a given stand with high-quality features (cultivar names usually refer to the locations of these stands). Most clones can be readily propagated by greenwood or root cuttings. Grafting can also be accomplished relatively easily. However, owing to the high production costs of planting material and the lack of suitable reference plantations, the use of improved black locust cultivars in operational forestry has declined drastically over recent decades. This is despite the fact that, according to cultivation trials, mean tree volume values are generally almost identical, whereas indicators reflecting stand quality show an advantage of 8–15% in favour of the selected cultivars in the majority of the trials. It should be emphasised that the cultivation of selected black locust cultivars is worthwhile only under excellent or good ecological and site conditions. On 'poorer black locust sites', management is in the overwhelming majority of cases uneconomical, because the advantages of plantation-type growing technologies cannot be fully exploited (Keresztesi 1988; Rédei 2006).

The aim of the present study is to provide a comprehensive evaluation of the cultivation trials of the 'Nyírségi' black locust cultivar and to synthesise the knowledge accumulated on the cultivar. The study presents the dendrometric characteristics of 12 'Nyírségi' black locust stands and also includes a case study.

Characteristics of the 'Nyírségi' black locust. The 'Nyírségi' black locust is a cultivar developed for timber production, particularly suitable for the production of sawlogs. It is the result of the selective breeding work of Béla Keresztesi, József Fuisz, and Eszter Szabó. Originally, it was a clonal mixture of six plus trees selected from a black locust stand (shipmast type) near the village of Nyírbátor (Eastern Hungary), growing on reddish-brown forest soil. Subsequently, the maintainer of the cultivar reduced the original number of components to three clones (plus tree IDs 10, 11, 12). The cultivar has been officially registered since 1973 (Keresztesi 1988; Rédei 2006). Based on recent genetic fingerprint analysis, the two plus tree genotypes 11 and 12 turned out to be genetically identical, while genotype 10 remained unique. This latter one can be found only in gene collections, and the plantations are dominated by the identical genotypes 11 and 12.

The morphological characteristics of the cultivar are as follows. The stem is straight and extends continuously through the crown. The bark is slightly rough due to prominent, scattered cork warts (lenticels), which are only slightly contrasting in colour. It is brown, with longitudinal greenish and light-brown stripes and a small number of clearly visible transverse ridges. The branches are straight and form acute angles with the stem. The crown is very vigorously developed. The leaves are typically alternate. The leaflets are compressed-elliptical in shape, with blunt, emarginate apices; their average length is 4.9 cm and width is 2.5 cm. The foliage is dense. The thorns are large, with an average length of 1.3 cm, and are reddish-brown in colour. The inflorescences are white, borne in short racemes, with an average of 16 flowers per raceme. The number of flowers produced varies, whereas seed production is very poor. The flowering period is short (8–12 days), and the sugar content of the nectar is equivalent to that of common black locust (Keresztesi 1988).

Experimental data reveal that the 'Nyírségi' cultivar and the control (common black locust with

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seed origin) do not differ significantly with regard to yield, whereas a significant difference was found in stem quality (Keresztesi 1988; Rédei et al. 2017). In a short-rotation energy plantation trial established on marginal sandy site conditions in Central Hungary (Helvécia), the 'Nyírségi' cultivar produced mean annual increments of oven-dry stem dendromass of 2.4 t·ha^{-1}·yr^{-1}, 5.7 t·ha^{-1}·yr^{-1}, and 6.7 t·ha^{-1}·yr^{-1} at ages 3, 5, and 7 years, respectively, at a stocking density of 6 667 stems·ha^{-1}. Common black locust yielded 3.6t·ha^{-1}·yr^{-1}, 6.7 t·ha^{-1}·yr^{-1}, and 8.4 t·ha^{-1}·yr^{-1} at the same ages, confirming the lack of significant difference in dendromass production between the cultivar and the control. When comparing the respective yields produced by the black locust clones and the common black locust, it becomes evident that using expensive black locust clonal material for setting up short rotation plantations has no added value (Rédei et al. 2011).

MATERIAL AND METHODS

In the present study, we evaluated the results of a stand structure investigation conducted in 12 'Nyírségi' black locust stands of different ages (7–35 years), located in 9 forest compartments. The experimental sites are situated near the settlements of Tét, Tahitótfalu, Gödöllő, Mikebuda, Helvécia, Szentkirály, and Ófehértó (Figure 1).

The stands are located in sessile oak–Turkey oak and forest-steppe climatic zones, predominantly on free-draining sites. The soil conditions are characterised by humous sandy soils or rusty-brown forest soils, with moderately deep (medium) soil layers and sandy or sandy loam soil texture [based on Hungarian site typology by Járó (1972)]. The site characteristics were determined based on forest management plan data (Table 1).

Three 500 m^2 sample plots were established in each forest compartment, except for Gödöllő 5/G, where four plots were designated. In all cases, planting was carried out using a spacing of 2.4 × 1.0 m. Tending operations were performed at the ages of 8–11 years (cleaning) and 15–20 years (thinning), depending on site conditions, based on the tending model developed by Halupa and Rédei (1988).

Based on tree-level measurements, we determined or calculated the mean stand height (Lorey's height, H_L), quadratic mean diameter (*QMD*), mean basal area of an average tree (*ba*), mean tree volume (v), basal area per hectare (*BA*), stand volume per hectare (V), and number of trees (without dead trees) per hectare (N), following the relevant forest mensuration literature (Burkhart et al. 2019). The volume of an average tree was calculated using the equation by Sopp and Kolozs (2013).

The number of trees per hectare (N) was determined by converting the number of trees recorded on the experimental plot to a per-hectare basis. Stand volume per hectare, i.e. total growing stock, was calculated using the equation $V = v \times N$. Basal area per hectare (*BA*) was determined as the

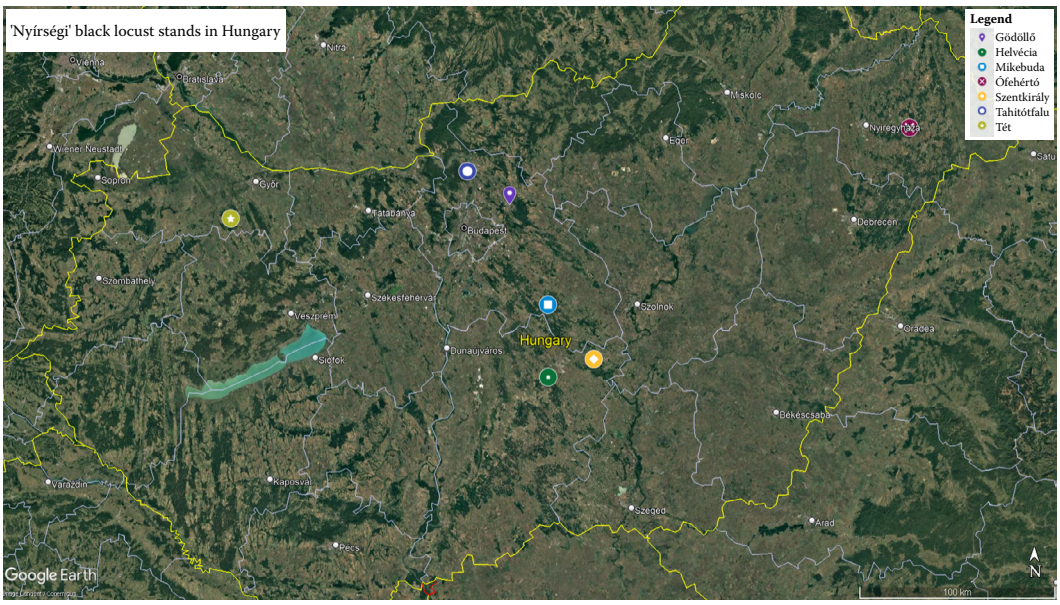

Figure 1. Location of the 'Nyírségi' experimental stands (Google Earth)

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Table 1. Site type of 'Nyírségi' black locust stand, based on Hungarian site typology by Járó (1972)

Subcompartment	Climate	Hydrology	Soil type	Depth of topsoil	Soil texture
Mikebuda 12/H	forest-steppe	free-draining site	humic sand soil	medium	sand
Gödöllő, Arboretum	sessile oak–Turkey oak	free-draining site	rusty brown forest soil	deep	sand
Szentkirály 40/F	forest-steppe	free-draining site	humic sand soil	medium	sand
Tahitótfalu	sessile oak–Turkey oak	free-draining site	rusty brown forest soil	medium	sandy loam
Ófehértó 13/F	sessile oak–Turkey oak	free-draining site	humic sand soil	medium	sand
Szentkirály 47/H	forest-steppe	free-draining site	humic sand soil	medium	sand
Tét 16/K	sessile oak–Turkey oak	free-draining site	lessivated brown forest soil	shallow	sand
Helvécia 67/B	forest-steppe	free-draining site	humic sand soil	medium	sand
Gödöllő 5/G	sessile oak–Turkey oak	free-draining site	rusty brown forest soil	medium	sandy loam

product of the number of trees per hectare and the basal area (*ba*) calculated from the mean diameter at breast height. During data processing, the dendrometric parameters of the plots were averaged.

To estimate the growth and yield of selected black locust cultivars, a yield table comprising five yield classes was constructed. Yield class indicates the relative growth performance of a stand compared with other stands of the same tree species across the country, with classes ranked from I (best) to V (worst) using Roman numerals. In plantation forestry, yield classes I–IV are generally considered to meet the silvicultural and economic requirements (Rédei et al. 2021). In this study, the investigated stands were assigned to the respective yield classes based on their height values, using the height curves of the yield table.

The experimental stands were investigated based on the relationships between *N* and *QMD*, and mean tree volume and *QMD*. These relationships were characterised using second-degree polynomial and exponential functions. Data analyses, model fitting, and graphical representations were performed using Microsoft Excel (Version 365).

In our case study, we compared the vegetatively propagated 20-year-old 'Nyírségi' cultivar with a black locust stand originating from seedlings (control) in a clone trial located in forest compartment Szentkirály 47/H (46°97'44"N, 19°87'89"E), on a poor-site, slightly calcareous humus-rich sandy soil. The study area receives approximately 500–550 mm of precipitation annually, while the estimated annual runoff amounts to 16 mm. The mean annual air temperature ranges between 10 °C and 11 °C, with the lowest monthly average of –1.5 °C recorded in January and the highest, reaching 21 °C, in July. The region is also increasingly exposed to extreme weather conditions, particularly prolonged periods of drought and episodes of intense rainfall (Szinetár et al. 2018; Szabó et al. 2022).

Three plots (size: 20 × 25 m) were available for each genotype. The planting spacing is 2.4 × 1.0 m. At the time of the inventory, we measured the height and diameter at breast height (*DBH*) of a total of 180 trees of 'Nyírségi' and 199 control trees, and we assessed the quality of their stems. For this purpose, a four-class ordinal scale was used based on stem straightness, cylindrical form, forking, branching characteristics, and visible stem defects, following the classification criteria described by Rédei et al. (2013). Class 1 represented the highest stem quality, characterised by a straight, cylindrical, and healthy stem extending to the top of the crown. Crooks were permitted in one dimension only and could not exceed twice the stem diameter. Class 2 represented good stem quality, with a straight stem; forking was permitted only in the uppermost third of the tree, and crooks in one dimension could not exceed three times the stem diameter. Class 3 represented poor stem quality and included crooked, leaning stems with crooks reaching up to five times the stem diameter in one dimension; minor crookedness in a second dimension was also tolerated. Class 4 represented the lowest stem quality and included trees with severe crookedness in more than one dimension, low branching, forking accompanied

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by stem defects, a broken crown, or stem rot. Thus, lower class numbers indicated better stem quality, whereas higher numbers indicated poorer stem form and/or more severe defects.

The analysis of stand structure, as well as the classification of individual trees according to height and silvicultural class, was carried out in accordance with the systems of Fekete (1951) and Kraft (1884).

Height categories:

(*i*) Height class (I): Emergent trees. The crown is completely free from above and partially free from the sides. The crown is exceptionally well developed, with its upper part extending above the uppermost layer of the stand.

(*ii*) Height class (II): Dominant trees. The crown is completely free from above, and a large part of it receives direct light. The crowns of trees belonging to this class form the upper crown layer of the stand.

(*iii*) Height class (III): Intermediate trees. Only the crown tip is free, and it still receives direct light. Laterally, the tree is under strong pressure from the crowns of taller neighbouring trees.

(*iv*) Height class (IV): Suppressed trees. Even the crown tip is not free and does not receive direct light. The tree is suppressed beneath the crowns of neighbouring trees but still belongs to the upper crown layer.

Tending categories:

(*i*) Tending class I: Superior trees. Trees with the best characteristics that are retained until final felling.

(*ii*) Tending class II: Subdominant trees. Trees in the main stand that are to be removed before final felling.

(*iii*) Tending class III: Trees to be removed. Individuals scheduled for harvesting during the next silvicultural and timber-production operations.

(*iv*) Tending class IV: Dead trees. Individuals that died between two stand inventories.

During data processing, values belonging to dead trees (individuals in tending class IV) were excluded. Thus, the statistical comparison was performed only on the live stand (160–168 trees).

Data were organised and statistically analysed using IBM SPSS Statistics (Version 27.0, 2020). During data processing, measurements from dead trees (classified in tending class IV) were excluded from the comparative analysis. Thus, the statistical comparison was based exclusively on the live trees, comprising 160 individuals in the 'Nyírségi' group and 168 individuals in the control group. For the comparative study of the two genotypes, the arithmetic means (± standard deviations) of tree height, diameter at breast height, and stem-quality scores were calculated separately for each plot. The resulting plot-level mean values from the three plots representing each genotype were used as independent observations. Differences between the two genotypes were evaluated using independent-samples t-tests, with the significance level set at $P < 0.05$. In addition, the diameter distribution of trees was analysed for the 'Nyírségi' stands to characterise their diameter structure.

RESULTS

The most important dendrometric characteristics of the experimental stands (*H*, *QMD*, *BA*, *V*, *N*, *v*) and their yield classes are summarised in Table 2. Based on the data from its long term (7–35 years) experimental plots, it was possible to compare the experimental data series with the corresponding values of the timber yield table developed for the selected black locust cultivars (Rédei et al. 2021).

It can be concluded that the vast majority of the 'Nyírségi' experimental black locust stands belong between yield classes II and IV, which means that they can achieve relatively high or medium yields under favourable site conditions. Figure 2 shows the scatter of mean heights for 5- to 35-year-old stands as a function of age.

We also studied the relationships between different stand structure factors of the experimental stands. Overall, it can be concluded that all results (*N*–*QMD* and *v*–*QMD*) show a very strong correlation between the studied parameters. The *N*–*QMD* relationship (Figure 3), which allows an approximate determination of the growing space considered necessary to reach a certain target diameter. This is of particular importance for black locust cultivars for industrial wood, as the main production objective is to maximise diameter growth above 10 years of age.

Figure 4 shows the relationship between the *v* and *QMD* of 'Nyírségi' black locust stands (see also Table 2). A very strong correlation ($R^2 = 0.9924$) can be observed between the two investigated parameters.

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Table 2. The most important dendrometric characteristics of Nyírségi black locust stands

Location, subcompartment	Age (yr)	H_L (m)	*QMD* (cm)	*V* ($m^3 \cdot ha^{-1}$)	*N* ($trees \cdot ha^{-1}$)	*BA* ($m^2 \cdot ha^{-1}$)	Mean tree volme (m^3)	Yield class
Mikebuda 12/H	7	6.5	5.6	32.90	2 103	5.13	0.016	IV
Gödöllő, Arboretum	10	13.4	9.3	95.43	2 018	13.71	0.047	II
Mikebuda 12/H	12	10.5	8.9	90.00	2 023	12.50	0.045	IV
Szentkirály 40/F	13	13.5	10.3	131.98	1 987	16.37	0.066	IV
Gödöllő, Arboretum	15	16.7	12.1	151.34	1 579	18.16	0.096	II
Tahitótfalu	16	14.0	12.1	145.10	1 540	17.60	0.094	IV
Ófehértó 13/F	19	14.3	13.4	131.80	1 120	15.90	0.118	IV
Gödöllő, Arboretum	20	19.1	15.0	188.73	1 101	19.46	0.171	II
Szentkirály 47/H	20	17.1	15.5	186.70	1 067	20.00	0.175	III
Tét 16/K	21	16.9	15.2	188.93	1 121	20.38	0.168	III
Helvécia 67/B	23	15.8	15.7	255.40	1 300	25.17	0.196	IV
Gödöllő 5/G	35	21.1	21.9	245.98	590	22.68	0.418	III

H_L – Lorey's height; *QMD* – quadratic mean diameter; *V* – stand volume per hectare; *N* – number of trees per hectare; *BA* – basal area per hectare

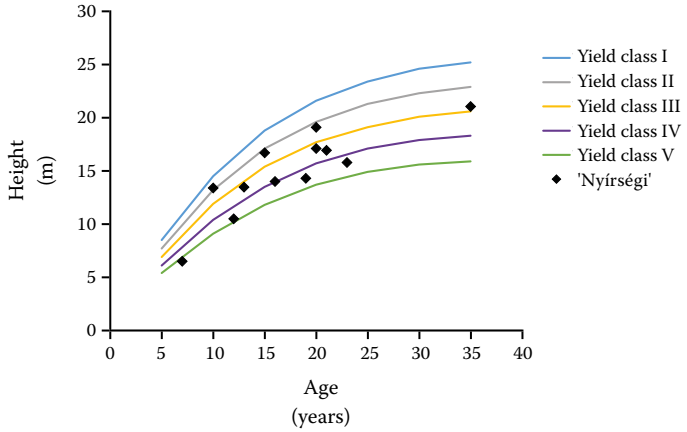

Figure 2. Distribution of the 'Nyírségi' experimental stands as a function of full stand height and age on the height curves of the yield table developed for the selected black locust cultivars (Rédei et al. 2021)

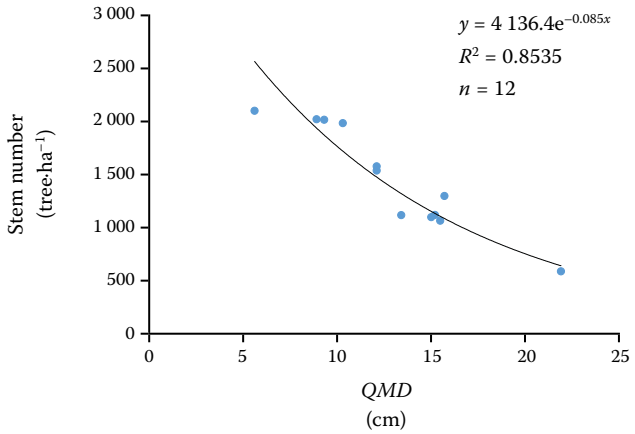

Figure 3. Stem number (*N*) in the 'Nyírségi' experimental stands ($n = 12$) as a function of quadratic mean diameter (*QMD*)

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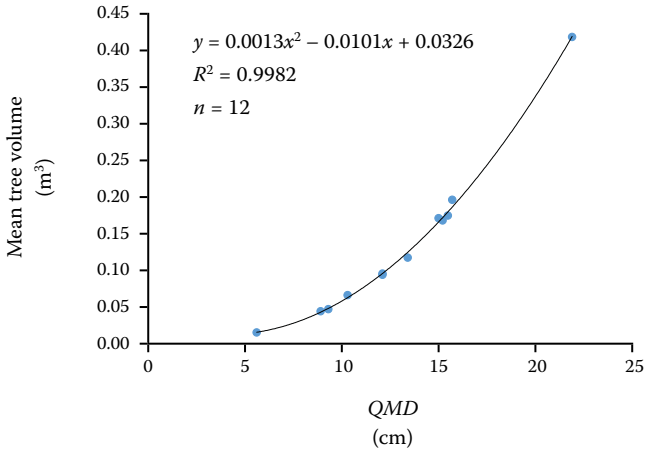

Figure 4. Mean tree volume in the 'Nyírségi' experimental stands (n = 12) as a function of quadratic mean diameter (QMD)

Case study in Central Hungary (under marginal site conditions). Studying the parameters of the experimental 'Nyírségi' black locust in the Szentkirály 47/H forest subcompartment, it can be concluded that at the age of 20 years, the H_L of the full stand is 17.1 m, the QMD is 15.5 cm, and V is 186.70 m^3·ha^{-1} (N = 1 067 trees·ha^{-1}).

During the analysis of stand structure, the measured trees were assigned to height and silvicultural classes. Accordingly, slightly more than one-quarter (26%) of the individuals of the 'Nyírségi' cultivar belonged to height class I, i.e. outstanding trees, while nearly half (43%) belonged to height class II (dominant trees). 19% were classified into height class III (intermediate trees) and 12% into height class IV (suppressed trees). In the control, the distribution was as follows. Height class I: 16%, class II: 36%, class III: 26%, and class IV: 22%. The mean height (H) by class varied between 12.6 m and 18.2 m for 'Nyírségi' and between 10.1 m and 19.4 m for the control (Table 3).

For the tending classes, 51% of the trees in the 'Nyírségi' cultivar and 44% of those in the control belonged to superior trees (tending class I). These trees are retained until final felling. Their mean height was 17.5 m for 'Nyírségi' and 18.2 m for the control, while DBH was 16.77 cm for 'Nyírségi' and 16.93 cm for the control. The proportion of dead trees (tending class IV) was 11% in the 'Nyírségi' cultivar, compared with 16%

Table 3. Key dendrometric characteristics (n, H, DBH, ba, v) by height classes of 'Nyírségi' cultivar at 20 years of age compared with common black locust in Szentkirály 47/H subcompartment

Height classes	n (trees)	n (%)	H (m)	DBH (cm)	ba (m^2)	v (m^3)
'Nyírségi'						
Height class I	46	26	18.2	18.15	0.026	0.259
Height class II	78	43	16.6	14.49	0.017	0.157
Height class III	35	19	14.8	12.58	0.013	0.108
Height class IV	21	12	12.6	12.35	0.012	0.096
Control						
Height class I	32	16	19.4	19.12	0.029	0.296
Height class II	72	36	17.2	14.81	0.018	0.166
Height class III	52	26	14.6	11.42	0.011	0.091
Height class IV	43	22	10.1	8.16	0.005	0.039

n – number of trees; H – arithmetic mean of the height values of trees within the given height class; DBH – arithmetic mean of the diameter (at breast height) values of trees within the given height class; ba – arithmetic mean of the basal area values of trees within the given height class; v – arithmetic mean of the mean tree volume values of trees within the given height class

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in the control, which was 5 percentage points higher (Table 4).

The 'Nyírségi' cultivar had a more favourable mean stem-quality score (2.06 ± 0.22) than the control (3.04 ± 0.09), with a difference of nearly one full class. The mean score was approximately 32% lower in the 'Nyírségi' cultivar than in the control, indicating better stem quality.

To provide a more detailed insight into this difference, the frequency distribution of the four stem-quality classes is presented in Table 5. In the 'Nyírségi' group, 75 % of the assessed trees belonged to Classes 1 and 2, compared with 23 % in the control group. Conversely, 25 % of the 'Nyírségi' trees and 77 % of the control trees were classified as Classes 3 and 4. The frequency distribution therefore confirms the more favourable stem-quality characteristics of the 'Nyírségi' cultivar, with a substantially higher proportion of trees belonging to the two better-quality classes.

In the case of the 'Nyírségi' cultivar, we also examined the *DBH* distribution of the entire live stand. The diameter distribution was unimodal and slightly positively skewed (skewness = 0.579; SE = 0.192). Most of the trees had a *DBH* between 11 cm and 19 cm, with a mean (± standard deviation) of 15.10 ± 3.30 cm and moderate variability (*CV* = 21.9%). The minimum value was 9.04 cm, the maximum was 24.51 cm, and the range was 15.47 cm. Towards the larger diameter classes, a less dense, elongated tail can be observed between 20 cm and 25 cm (Figure 5).

Table 4. Key dendrometric characteristics (*n*, *H*, *DBH*, *ba*, *v*) by tending classes of 'Nyírségi' cultivar at 20 years of age compared with common black locust in Szentkirály 47/H subcompartment

Tending classes	*n* (trees)	*n* (%)	*H* (m)	*DBH* (cm)	*ba* (m^2)	*v* (m^3)
'Nyírségi'						
Tending class I	91	51	17.5	16.77	0.023	0.218
Tending class II	58	32	15.8	13.08	0.014	0.122
Tending class III	11	6	13.7	11.93	0.012	0.093
Tending class IV	20	11	12.7	12.48	0.013	0.099
Control						
Tending class I	87	44	18.2	16.93	0.023	0.226
Tending class II	46	23	15.7	12.25	0.012	0.106
Tending class III	35	18	11.9	9.12	0.007	0.054
Tending class IV	31	16	10.9	8.79	0.006	0.047

n – number of trees; *H* – arithmetic mean of the height values of trees within the given tending class; *DBH* – arithmetic mean of the diameter (at breast height) values of trees within the given tending class; *ba* – arithmetic mean of the basal area values of trees within the given tending class; *v* – arithmetic mean of the mean tree volume values of trees within the given tending class

Table 5. Frequency distribution of stem-quality classes in the 'Nyírségi' and the control stands

Stem-quality class	'Nyírségi' – *n* (%)	Control – *n* (%)
1	43 (27%)	1 (1%)
2	77 (48%)	38 (22%)
3	29 (18%)	67 (40%)
4	11 (7%)	62 (37%)
Total assessed	160 (100%)	168 (100%)

Values are presented as the number of trees (*n*) and the percentage of all trees in the respective group; however, no statistically significant difference was found in growth; the mean (± standard deviation) height of 'Nyírségi' black locust (16.7 ± 1.23 m) exceeded that of the control (16.2 ± 0.26 m) by 3%; the *DBH* was 15.15 ± 1.17 cm for 'Nyírségi' and 14.01 ± 0.21 cm for the control, indicating that 'Nyírségi' also outperformed the control in this parameter (by 8%)

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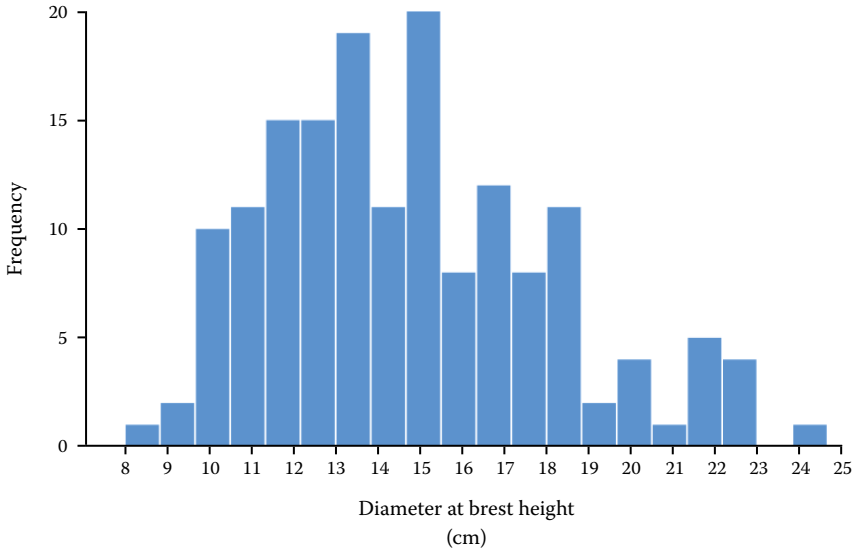

Figure 5. Diameter at breast height distribution of the 20-year-old 'Nyírségi' black locust cultivar (n = 160) in Szentkirály 47/H subcompartment

DISCUSSION

The potential future role of *Robinia pseudoacacia* in European forestry may be particularly relevant in the context of climate change and the projected decline of several major native tree species. An ensemble species distribution modelling study based on occurrence data from both the native and naturalised ranges of North American tree species indicated an increasing range potential for *R. pseudoacacia* in the introduced area under both RCP (Representative Concentration Pathway) 4.5 and RCP 8.5 scenarios for 2070 (2061–2080). The results further suggested that suitable areas may occur beyond the species' current distribution, supporting the potential for a continued or expanded role of black locust under future climatic conditions. Nevertheless, an increase in climatic range potential should not be interpreted directly as evidence of increased silvicultural productivity or suitability for forest production. The projected distribution patterns therefore provide an important indication of the species' potential under future climate conditions but should be complemented by site-specific assessments of growth performance, productivity and ecological impacts when considering its future role in European forestry (Albrecht et al. 2024).

According to some reviews (Nicolescu et al. 2020; Ábri et al. 2023), black locust breeding programmes have been carried out in several countries for decades, focusing primarily on improved wood quality, biomass production and drought tolerance. Hungary has a particularly strong tradition in black locust breeding and is currently a leading European country in the genetic improvement of the species (Keresztesi 1988; Rédei et al. 2008; Ábri et al. 2021, 2022, 2026). The Hungarian breeding programme has resulted in the selection of cultivars with improved and distinct growth and production characteristics (e.g. good stem quality), providing an important genetic basis for plantation forestry under different site conditions (Nicolescu et al. 2018; Ábri et al. 2023). However, the strong clonal growth of black locust and the resulting clonal structure of stands may also affect the genetic diversity of naturally regenerated or harvested seed, as uneven parental contributions and high selfing rates can lead to large full-sib families and an unbalanced distribution of alleles. Seed orchards comprising multiple selected clones may therefore provide a more balanced genetic composition of seed lots (Pakull et al. 2024).

Based on the growing technology developed and recommended by Rédei, the final cutting age of plantations established with selected black locust cultivars, including the 'Nyírségi' black locust, can be projected to be 30 years at a spacing of 2.5 × 2.0 m, and 20–25 years at a growing space of 3 × 3 m (9 m^2 per tree). Based on the research results obtained to date, it can be concluded that stands growing on favourable site conditions may attain heights of 25 m and 22 m, respectively, and breast-height di-

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ameters of 25 cm and 20 cm, respectively, within the above age intervals. The number of trees per hectare at final harvest may be expected to be around 450–500 stems·ha^{-1} (Rédei 2023).

Wood quality, including the chromatic properties of black locust heartwood, may also vary with growing site conditions. A recent study (Németh et al. 2026) of the 'Nyírségi' cultivar from five regions of Hungary found significant and clearly perceptible differences in heartwood colour among site types, while the characteristic yellowish hue remained stable regardless of site origin. These findings indicate that growing conditions may influence specific wood quality traits and should therefore be considered when evaluating the suitability of black locust cultivars for timber production.

The evaluation of 12 'Nyírségi' black locust stands aged 7–35 years provides a descriptive overview of their dendrometric characteristics and yield classes. The 20-year-old comparative case study further provides information on the performance of the cultivar relative to seed-origin common black locust under the specific site conditions investigated. Although no statistically significant differences in growth parameters were detected between the two genotypes, a significant difference was found in stem quality. The 'Nyírségi' cultivar had a lower mean stem-quality score (2.06 ± 0.22) than the control (3.04 ± 0.09), indicating a more favourable stem form. This finding is further supported by the frequency distribution of stem-quality classes, which showed a substantially higher proportion of trees in the two better-quality classes in the 'Nyírségi' group. The mortality rate was also lower in the cultivar (11%) than in the control (16%). However, these differences should be interpreted with caution, as the comparison was conducted at a single site and the results cannot necessarily be generalised to other site conditions. Overall, the findings suggest that the main potential advantage of the 'Nyírségi' cultivar lies in improved stem quality rather than a demonstrable increase in growth or yield. This observation is consistent with previous research on other improved black locust cultivars, which has also highlighted the importance of stem quality as a key selection trait (Keresztesi 1988, Ábri et al. 2021, 2023).

Although the improved stem form may be advantageous for the production of high-quality industrial roundwood, the economic benefits of using vegetatively propagated planting material require further assessment. The relatively high costs of root-cutting propagation and the need for skilled labour continue to limit the operational use of selected black locust cultivars. More efficient propagation technologies, including micropropagation, may contribute to reducing these costs. The practical application of the 'Nyírségi' cultivar should therefore be evaluated in relation to site conditions, propagation costs, and timber-quality objectives. Further research is needed to determine the most appropriate rotation length, planting spacing, and proportion of improved planting material in mixed stands under different site conditions. Economic assessments are also needed to determine how these silvicultural options affect timber production and the profitability of using improved planting material.

Looking ahead, black locust cultivars may play an increasingly important role in the establishment of black locust industrial tree plantations managed at wider planting spacings and with short rotations (approx. 20–25 years), aimed at producing high-quality timber. Furthermore, cultivars may also be suitable for agroforestry systems.

CONCLUSION

The comprehensive evaluation of the 'Nyírségi' black locust (*Robinia pseudoacacia* L.) cultivar confirms its potential for primary timber production on suitable sites. Dendrometric analyses across 12 experimental stands aged 7–35 years demonstrate consistent performance in yield classes II to IV. While biomass increment does not significantly exceed that of common black locust, the cultivar provides a statistically significant 32% advantage in stem quality, which is a critical trait for industrial sawlog production. The case study further shows superior structural quality and lower mortality rates under marginal site conditions.

However, adoption to practical forestry remains limited by high propagation costs and management requirements. As European forestry adapts to climate change, black locust is expected to maintain or expand its range. Future progress depends on developing cost-effective propagation technologies and integrating these cultivars into sustainable plantation models.

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