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# Tree Health Survey Results of Juvenile Black Locust Clones

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**ABSTRACT**

The black locust (*Robinia pseudoacacia* L.) is a significant tree species in many European countries, especially Hungary. The Hungarian Forest Research Institute initiated a project in the 1960s to improve *Robinia* stem quality and yield. Five newly bred clones (Laposi, Napkori, Hajdúsági, Farkasszigeti, Püspökladányi) are currently undergoing tests in three trials (Debrecen, Napkor, and Nyírbogdány). Studying the health status of these clones is vital to the cultivar certification process. In September 2022 (Napkor) and August 2023 (Nyírbogdány, Debrecen), we investigated 30 trees per clone by estimating average foliage loss per individual and observing the extent and causes of damage to the crown (canopy), branches, and trunk in each experimental plot. At the same time as the tree health survey, NDVI measurements were also performed in Debrecen using Trimble Greenseeker handheld sensor. Our results indicate that the clones possess good drought tolerance; however, the NDVI results revealed significant differences between the clones: Laposi and Farkasszigeti have the highest NDVI values (0.76 and 0.77), and Püspökladány has the lowest (0.74). Napkori is the most susceptible to fungal disease, exhibiting significant incidences of bark necrosis caused by *Phomopsis petiolorum*. The rate of insect damage was negligible, even with low levels of damage by leaf miners, which are very common in black locust plantations.

**TANULMÁNY INFÓ**

*Kulcsszavak:*
Növényvédelem
Akácnemesítés
Stressz tolerancia
NDVI

**KIVONAT**

**Új akácklónok növényegészségi vizsgálatának eredménye.** Az akác (*Robinia pseudoacacia* L.) egyike a legfontosabb fafajoknak Európában, különösen Magyarországon. Hazánkban az 1960-as években kutatási projekt indult a fafaj törzsminőségének javítására, fatermésének fokozására. Napjainkban 5 újonnan szelektált akácklónt (Laposi, Napkori, Hajdúsági, Farkasszigeti, Püspökladányi) vizsgálunk 3 klónkísérletben (Debrecen, Napkor és Nyírbogdány). A növényegészségi vizsgálatok kiemelt fontosságúak a fajta elismerési eljárás során. 2022 szeptemberében (Napkor) és 2023 augusztusában (Nyírbogdány, Debrecen) klónonként 30 fát vizsgáltunk minden kísérleti területen. Az állományvizsgálat során egyedenként megbecsültük az átlagos lombvesztést, valamint a koronában (lombozaton), ágakon és a törzsön előforduló károsodások mértékét és a kiváltó okokat. Debrecenben, ezzel egyidőben, NDVI mérest is végeztünk Trimble Greenseeker kézi műszer segítségével. Összegezve az eredményeket, megállapítható, hogy a vizsgált akácklónok jó szárazságtűrő képességgel rendelkeznek, ugyanakkor az NDVI értékek tekintetében szignifikáns különbség mutatkozott: a Laposi és Farkasszigeti (0,76 és 0,77) esetében mértük a legnagyobb és a Püspökladányinál a legkisebb NDVI értékeket (0,74). Továbbá az is bizonyítást nyert, hogy a Napkori klón a *Phomopsis petiolorum* gombás fertőzésével szemben fogékonyabb. A rovarkárok aránya elhanyagolható volt, még a közönséges akácosokban igen gyakran előforduló aknázómolyok károsításának mértéke is igen alacsony volt a vizsgálati években.

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## 1 INTRODUCTION

Black locust (*Robinia pseudoacacia* L.) is a fast-growing, relatively drought tolerant, N-fixing, multi-purpose tree species native to eastern North America. Used for timber and firewood production and apiculture, it also plays a significant role in forest management and ecosystem services in many countries, including Hungary, Romania, Bulgaria, Poland, Germany, Greece, China, and South Korea for its $CO_2$ sequestration, landscape reclamation, and erosion control. Black locust adapts to many sites and climates (Keresztesi, 1988; Mantovani et al., 2014; Li et al., 2018; Nicolescu et al., 2020; Spyroglou et al., 2021; Ciuvăț et al., 2022; Martin, 2023). Its high resistance to pests and diseases has also contributed to its rapid spread in Europe since the 1600s. However, in recent decades, several insects (*Parectopa robiniella* Clemens, *Macrosaccus robiniella* Clemens, *Obolodiplosis robiniae* Hald.) and fungi (*Phloeospora robiniae* Höhn., *Phomopsis petiolorum* Desm. Grove) have been reported to damage mature trees and seedlings (Bakó and Seprős, 1987; Szabóky and Csóka, 1997; Vajna, 2002; Bálint et al., 2010; Wilkaniec et al., 2021; Ermolaev et al., 2023). Fortunately, the locust borer (*Megacyllene robiniae* Forst.) is not yet present in Europe (Nicolescu et al., 2020).

Concerning other insects, leaf miner caterpillars (*Parectopa robiniella* and *Macrosaccus robiniella*) reduce leaf assimilation by mining. High populations of these pests can cause early defoliation of black locust (Tóth, 2002; Medzihorský et al., 2023). The black locust gall midge (*Obolodiplosis robiniae*) can cause considerable damage in some years. The female lays the eggs on the leaves, and the hatching larvae deform the leaves severely, inhibiting proper leaf development and significantly reducing assimilation surfaces (Csóka, 2006; Skuhravá et al., 2007).

Major black locust fungal pathogens are rare; however, two are worth mentioning. The first is a canker disease caused by *Phomopsis petiolorum* (syn *Phomopsis oncostoma*), which most often occurs in weakened one- to four-year-old juvenile stands. Infections develop from May onwards on dead shoots caused by late frosts but can also affect pruning wounds and other damage. As the disease progresses, the bark becomes increasingly necrotic, turning brown on the thinner green shoots in the infected parts. Callus canker sores develop on the trunk and around the stub of limbs. Bark disease also exposes the xylem of trunks, which break, causing tree death. Prevention is the best control against *P. petiolorum* (e.g., suitable site selection, avoiding frost pocket sites, and healthy plant material). Dead specimens and parts of branches should be removed as soon as possible and then destroyed (burned) if infestation has already occurred. Pruning should be performed carefully (Michalopoulos-Skarmoutsos and Skarmoutsos, 1999; Tóth, 2002; Vajna, 2002). Infection by the other pathogen, *Phloeospora robiniae*, also starts in early summer, with increasingly large, continuous brown spots on the leaves. Infected leaves often become deformed (Kehr and Butin, 1996; Wilkaniec et al., 2021).

We must mention game damage: European hare (*Lepus europaeus* L.) and European rabbit (*Oryctolagus cuniculus* L.) peel the bark from trees, while deer (*Cervus elaphus* L., *Capreolus capreolus* L.) browse young shoots, leaves, and buds. The black locust stands that the current paper studied are often fenced, which limits game damage (Tóth, 2002; Nicolescu et al., 2020).

*Robinia* has some abiotic stress factors (e.g., breakage by wind or heavy snow), but the most significant is frost, which damages unhardened twigs, causing forking. Although black locust trees are drought tolerant, heat and extreme drought negatively affect their growth (Tóth, 2002; Nicolescu et al., 2020).

We have detailed the abiotic and biotic stress factors. It is also worth mentioning human-induced (mechanical) damage caused by cultivation tools.

Many countries conduct black locust improvement research, with Hungary at the forefront of producing many black locust cultivars and candidate varieties. The Hungarian research program to improve the stem quality of *Robinia* and increase its yield started in the 1960s

(Keresztesi 1988). Five newly bred black locust clones (Laposi, Napkori, Hajdúsági, Farkasszigeti, Püspökladányi) are undergoing tests in three clone trials (Napkor, Nyírbogdány, Debrecen). Growth, vitality, and plant physiological characteristics are studied at these sites. (Ábri et al., 2022, 2023a, 2023b)

This paper presents the results of tree health surveys of the mentioned clones. The study provides data on the vitality and stress tolerance of the tested clones, which will be beneficial in the cultivar certification process.

The main questions of the current study are the following:

1. What is the health status of the studied clones? Are they drought-tolerant? Are there any pests to which any of the clones are susceptible?
2. What is the optimal planting spacing for the tested clones?

## 2 MATERIALS AND METHODS

### 2.1 Study sites of clone trials

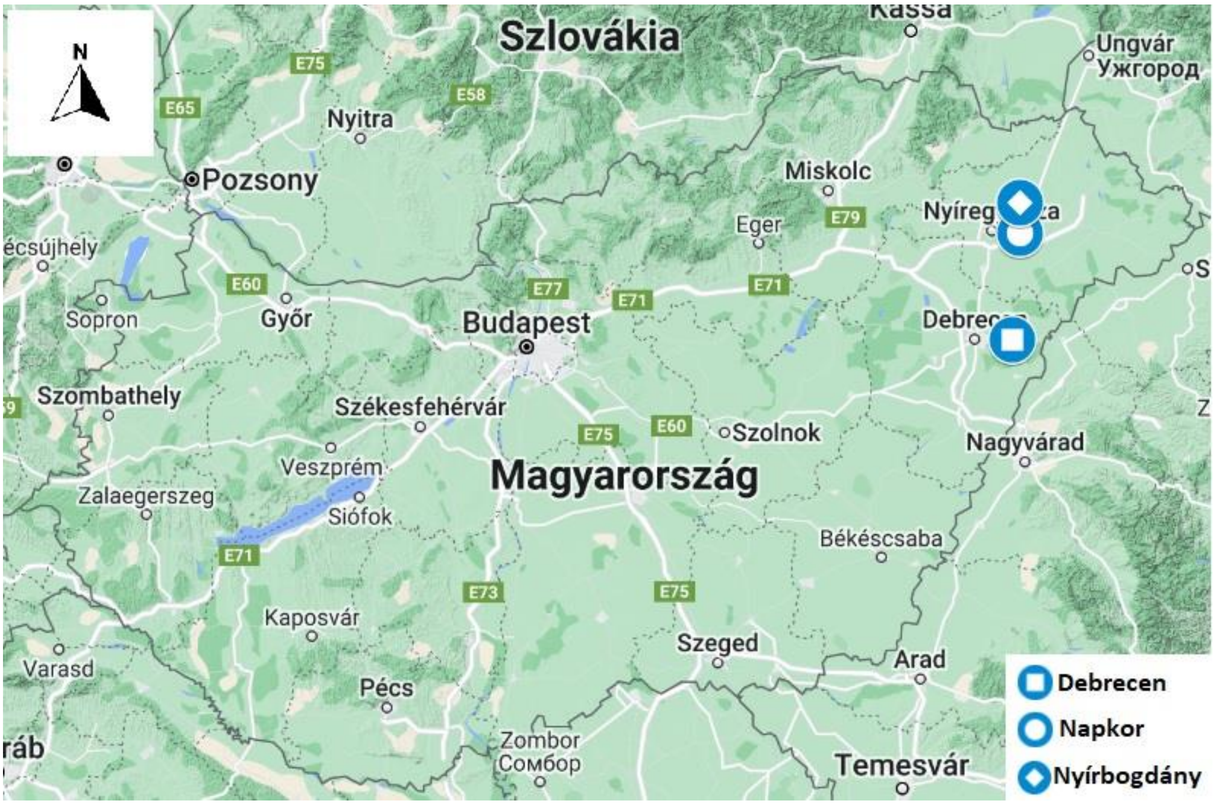


*Figure 1. Location of study sites in Eastern Hungary*

*Napkor and Nyírbogdány*

We have two experiments in the Nyírség region in eastern Hungary (*Figure 1*), the foremost black locust growing area. One of the clone trials is near Napkor, where four clones (Laposi – breeding sign: NK1, Napkori – breeding sign: NK2, Farkasszigeti – breeding sign: PL040, Püspökladányi – breeding sign: PL251) and cultivar Üllői (control) are studied in three different planting spacings (2.5 m ×2.5 m; 3.0 m × 3.0 m; 4.0 m × 4.0 m). The trial was conducted in 15 plots in total (Ábri et al., 2022, 2023a). The other is Nyírbogdány, where the Hajdúsági (breeding sign: PL035), Farkasszigeti, Püspökladányi, and Napkori clones are tested and compared with ‘Ópályi’ black locust (control). The clones were planted in three planting spacings, as in the Napkor experiment. Both clone trials were established in 2020. The study sites are acidic sandy soil with low humus content (1% > Hu%) (Ábri et al. 2023a).

The mean annual temperature is 10.6 °C in this area, and the mean annual precipitation is 537 mm based on long-term data (1991–2020) of the nearest Hungarian Meteorological Service station in Napkor. In the years of our tree health surveys, the mean temperature was higher by 1.1 °C (2022) and 1.6 °C (2023), and precipitation was 120 mm less in 2022 and 156 mm more in 2023 (Ábri et al. 2023a, HMS, 2024).

*Debrecen – subcompartment Debrecen 189V*

In subcompartment Debrecen 189V (*Figure 1*), the tested clones (NK1, NK2, PL035, PL040, PL251, and common black locust as control) were planted in 2.5 m × 1.5 m planting spacing. The experiment started in 2022. Our soil analysis results indicate that the humous content is low, and the soil pH was slightly acidic in the topsoil and increased with soil depth. In Debrecen, the mean annual temperature is 11.0 °C, and the mean annual precipitation is 543 mm (Gombos et al. 2023). In 2023, the health status investigation year, the mean temperature was higher by 1.6 °C, and precipitation was 121.5 mm higher. It is worth mentioning the extreme heat and drought in the planting year. In 2022, the mean temperature was higher by 1.1 °C, and precipitation was 101 mm less. In the period from May to August, the amount of precipitation was 69.5 mm, which is considerably below the 30-year average (240 mm) (*Figure 2*) (HMS 2024).

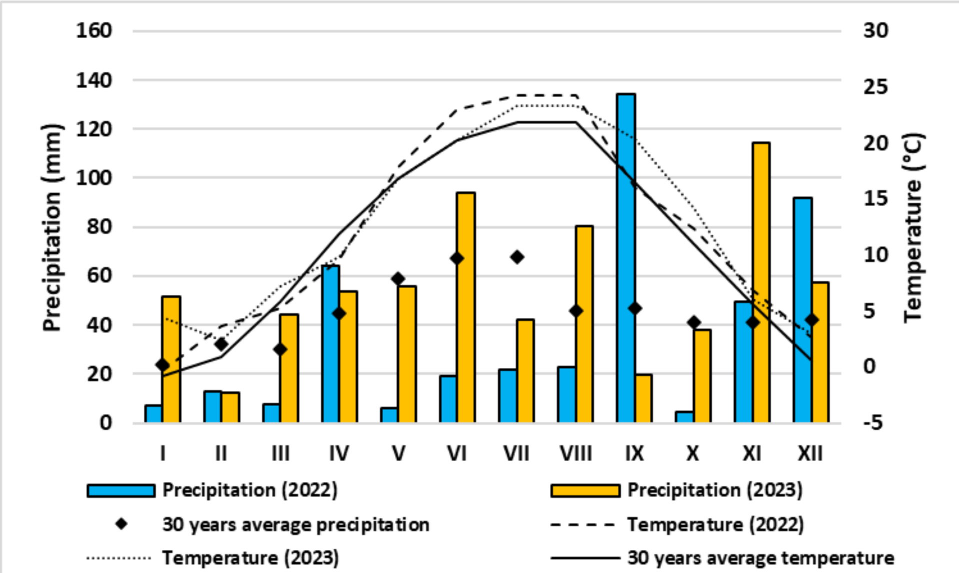


*Figure 2. Monthly precipitation sums and temperature averages (Debrecen, 2022 and 2023). Numbers in the bars: monthly sum precipitation. Note: The 30-year averages are based on Gombos et al. 2023, and the 2022-2023 meteorological data are from HMS 2024.*

## 2.2 Method

The tree health surveys were performed on 30 randomly selected individuals per clone in September 2022 (Napkor) and at the end of August 2023 (Nyírbogdány, Debrecen) after the cycle of main pests. For the investigation, we used an etalon tree, which was chosen locally. The ages of the studied clones are two (Debrecen), three (Napkor), and four (Nyírbogdány) years old. The average defoliation per individual was estimated in each experimental plot (and each planting spacing), as were the extent and causes of damage to the crown (canopy), branches, and trunk.

The average defoliation value represents the actual physical foliage loss relative to the total canopy area, which can occur due to several biotic and abiotic causes. The cumulative foliage loss value due to these causes provides the average foliage loss for a given clone.

Biotically caused leaf loss was also determined according to the emerging pests and pathogens. The frequency of occurrence (% of leaflets affected by the damage) and damage intensity (average percentage of leaf area affected) were recorded for the different foliage damage types. These two data are complementary and provide an accurate picture of the significance of a damage type. For example, in an extreme case, if all leaves show symptoms of fungal infection (frequency 100%) but only 1% of the leaf area is affected, then the intensity is 1%.

Abiotic defoliation is foliage loss due to drought and other abiotic factors (e.g., windbreak, frost, etc.) and is usually determined by the number of damaged, symptomatic leaves still present in the crown and by the number of fallen, discolored leaves, not including foliage loss due to crown breaks. Crown damages are in a separate category with a % value, which indicates crown break intensity, i.e., the percentage of the broken crown part of the total crown.

Pathogen incidence and intensity on trunks — in most cases (*Phomopsis petiolorum*) — is also expressed as a percentage. The frequency value indicates the % of the individuals tested that displayed fungal infection on the trunk, while the intensity % indicates the % of the trunk perimeter exhibiting bark necrosis caused by the fungus. Infection frequency, i.e., the number of individuals infected, is of greater importance for the analysis and data evaluation. The latter indicates the susceptibility of the clone to fungal infection. Intensity is of secondary importance in this case, as necrosis extension after fungal colonization is inevitable.

In Debrecen, we performed Normalized Difference Vegetation Index (NDVI)(Tucker 1979) measurements with a Trimble GreenSeeker handheld crop sensor. The sensor emits brief bursts of red and infrared light and then measures the amount of each light type reflected from the plant. The NDVI values range from 0.00 to 0.99 (Trimble 2024). We measured 30 trees/clones. Before the comparison, the homogeneity of variances was tested with the Levene test, and the normal distributions in the groups were tested with the Shapiro-Wilk tests. As the measured NDVI data met the parametric test conditions, we used one-way ANOVA and Fisher's LSD post hoc test for pairwise comparison. Statistical analyses were performed with IBM SPSS 25.0 statistical software.

## 3 RESULTS AND DISCUSSION

### 3.1 Defoliation

*Napkor*

The average defoliation rate was the lowest in the densest planting spacing (2.5×2.5 m), while the other two spacings had slightly higher values, but none reached 25 %. The two wider planting spacings showed broadly similar values. However, when evaluating the results by clone, we discovered that clones PL251 and NK1 showed significantly less defoliation than the other clones in all three planting spacings (*Figure 3*).

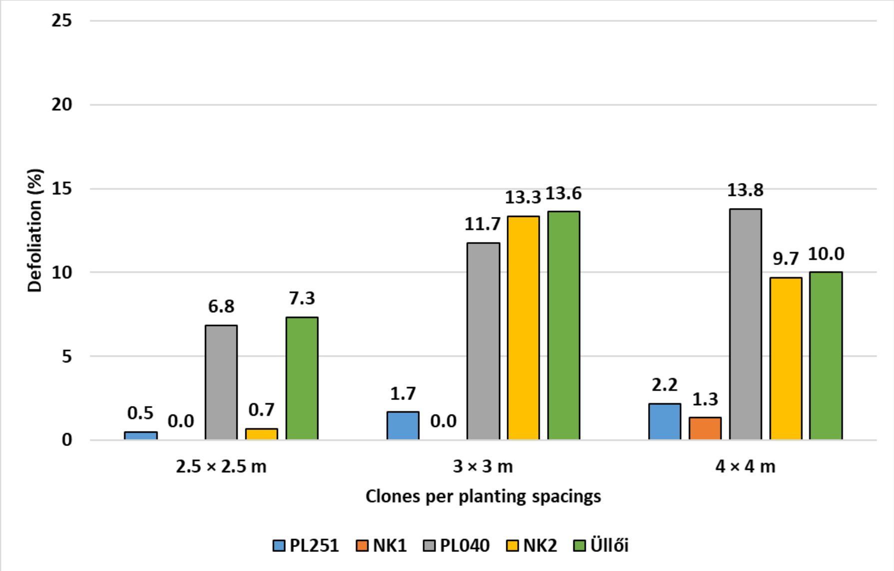


*Figure 3. Average defoliation (%) of the clones (n = 30) in 3 different planting spacings (Napkor, 12/09/2022)*

*Debrecen*
The average defoliation rate for the different clones did not exceed 25 % in any of the cases. The highest value, 24.3 %, was observed for clone PL040, but clone PL251 displayed a similar 24 % value. This value remained below 2 0% for the other clones. Clone NK2 had the lowest average defoliation at 9.8 % (*Figure 4*).

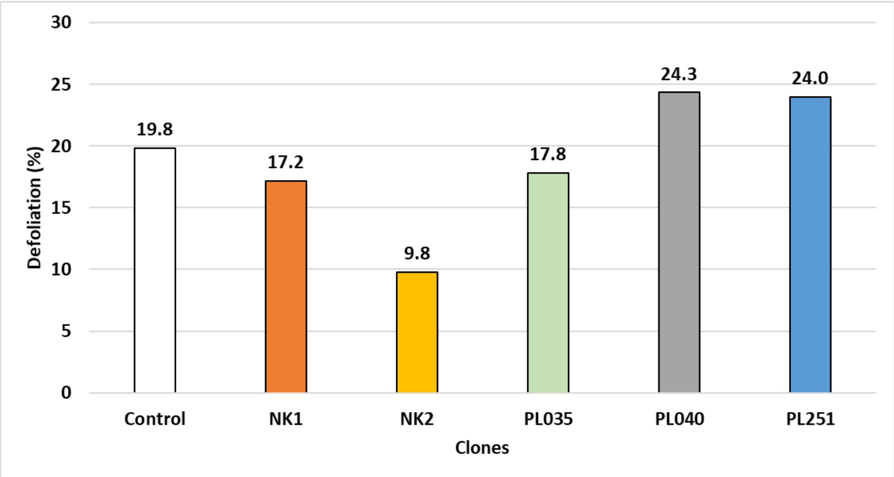


*Figure 4. Average defoliation (%) of the clones (n = 30) (Debrecen, 21/08/2023)*

## 3.2 Abiotic damages

*Napkor*
In this category, we mainly summed up the defoliation caused by drought and windthrow. The data showed relatively low % values for all clones. Perhaps the most notable was clone NK1, which had an abiotic leaf loss of 0 % in the 2.5×2.5 m and 3×3 m planting spacings but only 10% in the widest one (4×4 m). No outliers were observed for the other clones despite a severe drought in the area in the investigation year (2022), but the impact was relatively moderate. However, it is difficult to determine whether good site factors or the drought tolerance of the clones resulted in these values (possibly a combination of both).

*Nyírbogdány*

Relatively low percentages were observed for all clones in the Nyírbogdány experiment. The lowest values were in the widest planting spacing (4×4 m) with 0–4%. The values were similar in the other two spacings, usually between 4–6 %.

*Debrecen*

Data from Debrecen also showed relatively low % values for all clones. Perhaps NK2 was the clone with the lowest abiotic leaf loss, at only 2.5 %. The highest value was 15.7 % for PL251, which is still insignificant. The average drought-induced defoliation of the other clones ranged from 6–12 %. The NDVI measurement results in the experimental plantation in Debrecen are also reported. A considerable difference ($p$ = 0.05) was found between the mean (± standard error) NDVI values of the studied clones. PL040 (0.78±0.0071) was the best, and PL251 (0.74±0.0067) was the weakest, while no significant differences were observed between the latter and the control, common black locust (0.75±0.0063), nor between clones NK1 (0.76±0.0072) and PL040 (*Figure 5*).

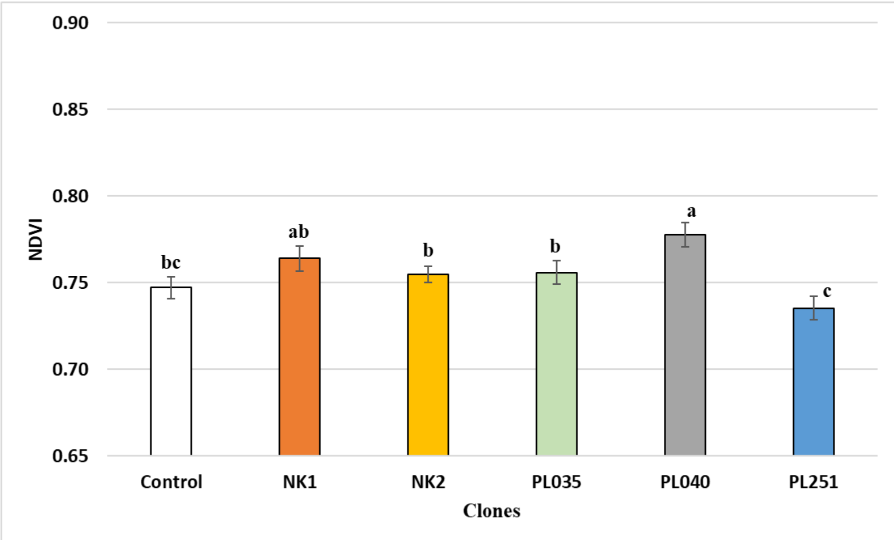


*Figure 5. Comparison of the studied clones (n = 30) by their NDVI values using Fisher's LSD post hoc test, ±standard error (Debrecen, 21/08/2023)*

## 3.3 Biotic damages – insect and game damage

We observed damage caused by leaf-mining moths, *Sitona* spp., and black locust gall midge in Nyírbogdány and Debrecen in the survey years, while in Napkor, we only observed symptoms caused by leaf miners. Overall, insect damage was negligible at all three sites. There were no notable differences in clone susceptibility or planting spacings in terms of damage extent. The differences observed can be considered rather random. However, the damage of the recently introduced black locust gall midge (Csóka, 2006; Csóka et al., 2017) is worth monitoring to determine whether there are differences in damage in narrower and wider planting spacings.

Game damage was only observed in Debrecen because that experimental plantation was not fenced. Damage varied from 10–27 %, mainly at the shoot tips, with an average intensity. The experiment results may be affected by chewing damage to the extent that tree height growth in the initial period (until the game reaches them) may be lower than that of the unaffected individuals due to the chewed shoots. The differences in individual clones were presumably not due to differences in susceptibility but to random feeding by the game.

### 3.4 Biotic damages – fungal diseases

In contrast to insect damage, pest susceptibility of the different cultivars and clones is not typical, but a clear difference in pathogen susceptibility did emerge. There are many examples of this, especially in the case of hybrid poplars, where there are significant differences in susceptibility to fungal diseases between the various cultivars (Tóth, 2006).

Our clone trials detected two pathogens: *Phomopsis petiolorum* in the Napkor and Nyírbogdány plantations and *Phloeospora robiniae* exclusively in the Napkor plantation.

Concerning the infection intensity of *Phloeospora robiniae*, clone PL040 showed a higher value than the other clones, and the difference was detectable in all three planting spacings, indicating that clone PL040 is more susceptible to *Phloeospora robiniae* infection. Another important finding is that higher planting spacing density (2.5×2.5 m) showed higher infestation rates. The probable reason for this is that the microclimatic conditions in the denser stand were more favorable for the pathogen. In addition, PL251 and NK1 clones were practically uninfected or only insignificantly infected (*Figure 6*).

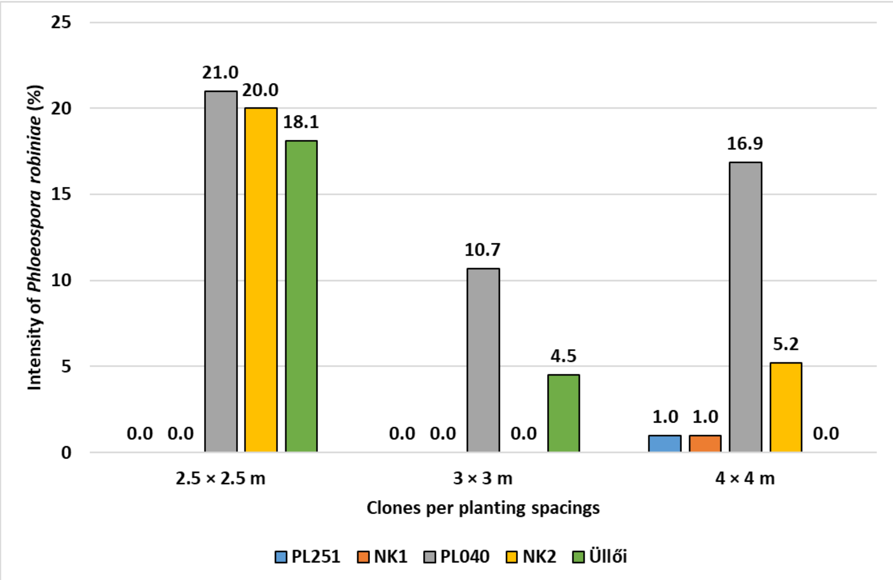


*Figure 6. Intensity of Phloeospora robiniae fungal disease on the studied clones (n = 30) in 3 different planting spacings (Napkor, 12/09/2022)*

The recording data indicates that the NK2 clone displays high susceptibility to *Phomopsis petiolorum* infection in all three planting spacings in Napkor. A moderate or high (30–50 % of the studied trees had the pathogen) infection. Also, the NK2 clone was highly susceptible to the mentioned disease in the experimental plantation in Nyírbogdány. Infestation also varied between planting spacings, with a relatively low infection rate of 13.3 % in the 2.5×2.5 m, 46.7 % in the 3×3 m, and 80 % in 4×4 m, which is very high. In addition, we observed *Phomopsis petiolorum* symptoms on sample trees of clone PL251 at a slightly lower rate and with increasing intensity in the wider planting spacings. The other clones displayed no such lesions (*Figure 7*).

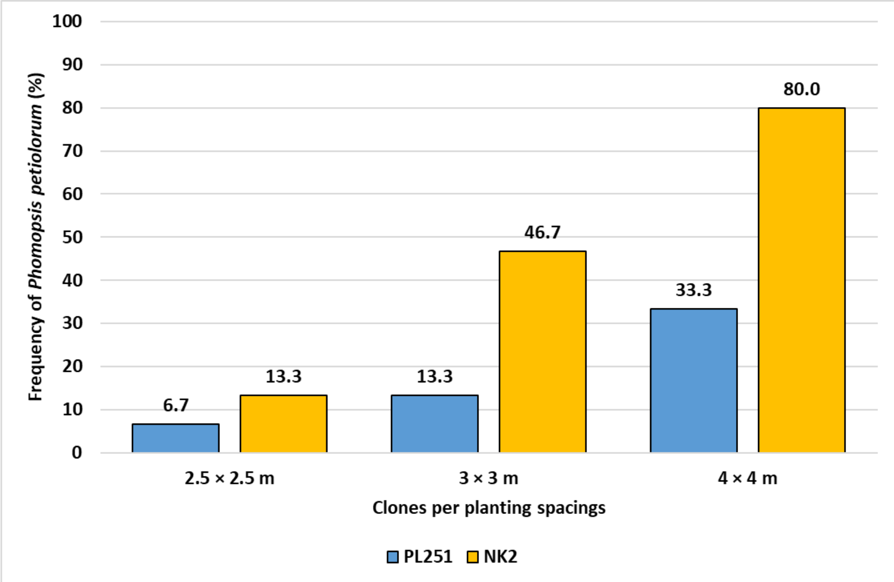


*Figure 7. Frequency of Phomopsis petiolorum fungal disease on the studied clones (n = 30) in 3 different planting spacings (Nyírbogdány, 22/08/2023)*

The high pathogen incidence was likely due to cultivation errors in the experimental plantations at Napkor and Nyírbogdány. Damage caused by inappropriately selected cultivators during interrow cultivation and late pruning creates favorable conditions for *Phomopsis petiolorum*, a wound parasite (Tóth, 2002). The above is confirmed by the fact that no signs of fungal disease were found in the two-year-old black locust plantation in Debrecen, where no pruning or late pruning had been done. However, care should be taken when growing the Napkori (NK2) and Püspökladányi cultivars (PL251).

## 3.5 Crown breaking

The crown break results of the current study are discussed separately. Major storms hit the Napkor experimental plantation in 2022, resulting in frequent crown breakage, especially in the more intensively pruned stands. Examining crown breaks by planting spacings detected no significant differences in the 2.5×2.5 m and 3×3 m, while a higher proportion occurred in the widest (4×4 m), obviously due to the freer stance. The data per clone reveals that the NK1 clone had a much higher rate of crown break than the other clones (33.3 % in planting spacings 2.5×2.5 m; 46.7 % in 3×3 m and 66.7 % in 4×4 m), which may be related to crown structure or tissue structure and strength indices. Studying the mechanical properties of the clone more closely from this point of view would be worthwhile (*Figure 8*).

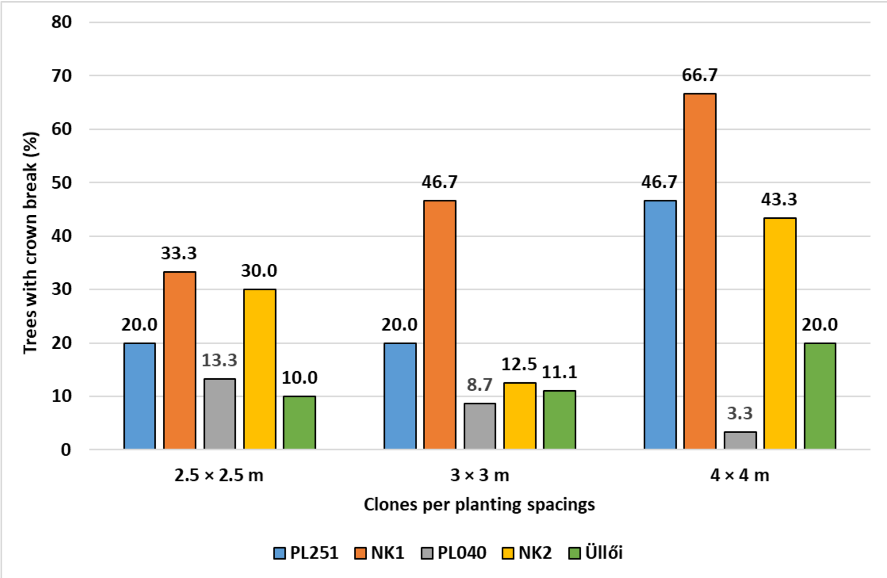


*Figure 8. Trees with crown breaks per clone (n = 30) in three different planting spacings (Napkor, 12/09/2022)*

In addition to the above, it would be worthwhile to establish different pruning experiments. Leaving the top third part of the trees intact is preferable to vigorous pruning.

### 3.6 Summary of the results

Based on Koltay (2009), we summarized the results of the plant health surveys of the three clone trials (Napkor, Nyírbogdány, and Debrecen) in *Table 1*.

*Table 1. Results summary of the plant health test on the studied clones*

| Napkor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Planting spacings | Clones | Defoliation | Abiotic defoliation | *Parectopa robiniella* | *Macrosaccus robiniella* | Obolodiplosis robiniae | *Phloeospora robiniae.* | *Phomopsis petiolorum* | Crown break |
| 2.5×2.5 m | PL251 | | | | | | | | * |
| | NK1 | | | | | | | | ** |
| | PL040 | | * | | | | * | | * |
| | NK2 | | * | | | | * | ** | ** |
| | Control | | * | | | | * | | |
| 3.0×3.0 m | PL251 | | | | | | | | * |
| | NK1 | | | | | | | | ** |
| | PL040 | * | * | | | | * | | |
| | NK2 | * | | | | | | ** | * |
| | Control | * | * | | | | | | * |
| 4.0×4.0 m | PL251 | | * | | | | | | ** |
| | NK1 | | | | | | | | *** |
| | PL040 | * | * | | | | * | | |
| | NK2 | | * | | | | | ** | ** |
| | Control | | * | | | | | | * |

| Nyírbogdány | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Planting spacings | Clones | Defoliation | *Abiotic defoliation* | *Parectopa robiniella* | *Macrosaccus robiniella* | *Obolodiplosis robiniae* | *Sitona* spp. | *Phomopsis petiolorum* | Crown break |
| 2.5×2.5 m | PL251 | | | | | | | | |
| | PL035 | | | | | | | | |
| | PL040 | | | | | | | | |
| | NK2 | | | | | | | * | |
| | Control | | | | | | | | |
| 3.0×3.0 m | PL251 | | | | | | | * | |
| | PL035 | * | * | | | | | | |
| | PL040 | | | | | | | | |
| | NK2 | | | | | | | ** | |
| | Control | | | | | | | | |
| 4.0×4.0 m | PL251 | | | | | | | ** | |
| | PL035 | | | | | | | | |
| | PL040 | | | | | | | | |
| | NK2 | | | | | | | *** | |
| | Control | | | | | | | | |

| Debrecen | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Planting spacings | Clones | Defoliation | Abiotic defoliation | *Parectopa robiniella* | *Macrosaccus robiniella* | *Obolodiplosis robiniae* | *Phloeospora robiniae.* | *Phomopsis petiolorum* | Crown break |
| 2.5×1.5 m | PL251 | * | * | | | | | | |
| | PL035 | * | * | | | | | | |
| | PL040 | * | | | | | | | |
| | NK1 | * | | | | | | | |
| | NK2 | | | | | | | | |
| | Control | * | * | | | | | | |

*The controls are Üllői (Napkor), Ópályi (Nyírbogdány), and common black locust* (Debrecen). *The * means the effect of the factors on the clone: * - weak (11–25 %); ** - medium (26–60 %); *** - strong (61 % <).*

Black locust was once a relatively healthy tree species but exhibits a clear downward leaf loss trend. According to the latest forest protection report (NLC 2023), only about a quarter of all Hungarian black locust trees were asymptomatic. Furthermore, several species-specific pests have appeared and spread in recent decades. *Parectopa robiniella* and *Obolodiplosis robiniae* should be made a priority species for controlling invasions of Robinia-specialist insects in Europe and Hungary (Zhang et al., 2024).

We concentrated on these pests and forest protection because the black locust is among the most commonly planted tree species in Hungary (covering approximately 23 % of the forested area).

Although the clones possess good drought tolerance, the NDVI measurement results reveal differences in this parameter. Minimal NDVI variation may highlight subtle genetic differences in traits such as water-use efficiency, photosynthetic activity, and adaptation to site conditions. In the context of tree health, NDVI values help indicate the general vitality of trees. High NDVI (0,7<) generally suggests healthy, dense foliage with active photosynthesis, while lower values (<0,6) can signify stress due to factors like drought, disease, pest infestation, or nutrient deficiencies. NDVI works well at sites where vegetation species are homogeneous (Maselli, 2004; Xiao and McPherson, 2005; Bahe et al., 2021).

## 4 CONCLUSIONS

The health status of the candidate cultivars under examination is essential for the variety certification procedure. Our study estimated and assessed the average defoliation and the extent and causes of damage to the canopy, branches, and trunk of five newly selected black locust candidate varieties. NDVI measurement is a useful supportive tool for assessing the general vitality of trees. In terms of pests and diseases, our results indicate that candidate cultivar Napkori (NK2) is susceptible to the fungal disease *Phomopsis petiolorum*, which we detected in two of the three black locust clone trials (Napkor and Nyírbogdány). Since no pruning had been done in the Debrecen experiment before our study, we assume that this is why we did not encounter diseased individuals here. Furthermore, late pruning in the Napkor and Nyírbogdány plantations also played a key role in the emergence of the disease. Even though we found *O. robiniae* damage, considered a dangerous invasive pest since the mid-2000s, in two experimental plantations (Nyírbogdány and Debrecen), the extent of the damage and other insect damage was negligible.

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