THE IMPACT OF INITIAL SPACING ON THE STAND STRUCTURE AND YIELD OF BLACK LOCUST (*ROBINIA PSEUDOACACIA* L.) STANDS AT CLEANING AGE

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Abstract

The paper presents research results on stands structure and yield in black locust (*Robinia pseudoacacia* L.) stands of various initial spacing at age of 7 and 12. The investigation has shown that there is no reason to increase the planting stock number per hectare over 4500–5000 in the afforestation phase – of course under the given site condition – that the growing space of seedlings must not be more than 2.0–2.2 m² per individual. Close correlation was found between the stem number per hectare and volume of mean tree as well as the reduced stem number after cleaning and the rate of changes in mean stem volume \((r² = 0.853)\). The right stem number after cleaning is about 1700–1800 per hectare in stands of III–IV yield classes. Calculating with an initial stem number of 10 000 per hectare the rate of dead tree volume is not more than 100 of the growing stock by the age of 12.

**Key words:** in black locust (*Robinia pseudoacacia* L.) stands, spacing trial, yield

INTRODUCTION

In Hungary black locust (*Robinia pseudoacacia* L.) is one of the most important stand-forming tree species, covering approximately 20 % of the forested area (345 thousand hectares) and providing about 18 % of the annual timber output of the country. Black locust timber can be used by industry (mining, construction and furniture) or by agriculture (post and pole wood), and the black locust stands are the main basis for Hungarian apiculture and honey production.

The right choice of initial spacing is one of the most important items of a plantation-like timber-growing technology (Veperdi, 1988; Halupa, Gabnai, 1990). But we have not got much reliable information on the impact of initial spacing on stand structure and yield of young black locust stands. The reason is a small number of relevant experiments. Timber-growing developments are aiming partly the tightening of the 2.4x0.7–0.8 m spacing used in the practical forestry or partly the use of wide spacing usual in Euramerican polar plantations. The following aspects must be considered in choosing the initial spacing:

**The narrow spacing:**
provides more gross initial timber volume,
the natural pruning of stem is promoted, crown closure comes in a rather
short time, the danger of weed growth is less intensive, chances for spontaneous selection of stems are better, but the diameter growth is less, the subsequent silvicultural operations are more expensive and the selling price of timber is less profitable, some operations, like soil cultivation can be mechanized with difficulties.

**The wide spacing:** provides less timber yield at the beginning, branch development is more intensive, crown closure is slower, weed growth is more aggressive, mean diameter is thicker and the rotation age can be somewhat reduced, financial charge of forest tending operations is lower and the timber volume produced can be sold at a more profitable price, some operations can be better mechanized.

Henceforth one of the few spacing experiments will be presented, namely at the of 7 and 12. On this way the impact of initial spacing choice – a very important nent of black locust growing – can be demonstrated on the stand structure and yield young black locust stands.

**MATERIAL AND METHODS**

The initial spacing experiment with black locust has been allocated in the compartment Némérték 87 A (region: Tengelic sands, towards the west of the river Danube). The site type is a free drained humus sand soil in the forest stepp climate zone, rootable depth is medium deep, the parent rock of soil and physical make-up: sand. Spacing variants of the experimental are:

1. 2.4x1.0 m;
2. 2.4x0.7 m;
3. 1.0x1.0 m.

The one-factorial experiment is in randomized arrangement, the number of etions is 3.

Yield class of the stand: III, at the age of 7 (Rédei, 1984). The experimental tings were carried out at the same time. At the age of 7 and 12 a complete recording all trees was done in each plot of the experiment. Determination of the most impor- tant structure and yield parameters was made by a special computer-program eloped for this purpose by the Hungarian Forest Research Institute.

Within qualification of stems the following classification was used: straight, healthy n (1); slightly warped, healthy or little injured stem (2); warped or space-curved, manently injured stem (3); almost or fully dead stems (4).

The stand quality index was calculated by the arithmetic mean of stem quality numbers weighted by the stem number. This quality index provided an objective way for the assessment of changes in quality after the clearings.

Variance analysis of mean height (H) and diameter (D_n) data was calculated by treatment variants at the age of 7. We tried to find relationships between the mean stem number per hectare and mean stem volume as well as between the reduced stem number after clearing and rate of changes in mean stem volume.

**RESULTS AND DISCUSSION**

Important stand structure and yield data at the age of 7 and 12 can be seen in Table 1.

On the base of the evaluation of treatment means at the age of 7 (Fig 1–7) the following conclusions can be drawn:

The stem number missing in relation to the initial spacing is nearly proportional with the spacing-density. Changes in stem number per hectare can be seen on Fig. 1.

The height-growth has not been influenced by the spacing. There is no signifi- cant difference at P = 0.05 level between the height values (Fig. 2).

Diameter at the breast height (total stand) is strongly influenced by the initial spacing, there is significant difference at P = 0.05 level between the spacing variants No. 1 and 2 as well as between No. 1 and 3 (SZD_{dbh}=0.8 cm). The spacing in row has more pronounced influence on the growth rate than the interrow distance (Fig. 3).

As for the basal area per hectare (G) and the growing stock (V_{koz}) the impact of stem number per hectare is shown up only at the densest spacing. In case of variants No. 1 and 2 the same row distance together with wider in-row-spacing results in stronger diameter growth and the stands despite their less stem number can produce somewhat bigger basal area and timber volume per hectare (Fig. 4 and 5).

The closeness in relation between growing space and diameter are demonstrated by the mean tree volume values (V_{max}) by variants (Fig. 6). We found significant difference at P = 0.05 level between the spacing-variants 1 and 2 as well as between those of No. 1 and 3.

In all treatment variants we measured 8–10 t/ha above-ground dendromass depending on spacing calculated in green weights for the total stand (Fig. 7).

Regarding the effect of clearings at age 7 on the stand structure and yield the following conclusions can be drawn:

The selective effect of pre-clearing stems number differences per hectare on the quality and quantity aspects of the main crop can be neglected.

There is a close correlation between the stem number and mean stem volume of the main crop at ages 7 and 12 (Fig. 8).

The equation describing this correlation is 
\[ y = 3 \times 10^x \times 1.073 \] 
\( r^2=0.788, n=18 \).

Little changes in stem number may cause major changes in the volume of mean stem, if the stem number per hectare is less than 2000. According to our investigations the near-desirable stem number of medium quality black locust stands (III–IV yield classes) is
Table 1
The most important stand structure and yield parameters of the black locust experimental stands (Nemec) 1987 A

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Age (years)</th>
<th>Main crop</th>
<th>Secondary crop</th>
<th>Total crop</th>
<th>Deadwood</th>
<th>Sand quality under 12 year total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>4x1.0 m</td>
<td>7.8</td>
<td>7.3</td>
<td>10.852</td>
<td>2.566</td>
<td>61.6</td>
</tr>
<tr>
<td>Controls</td>
<td>12</td>
<td>12.5</td>
<td>11.8</td>
<td>10.850</td>
<td>1.517</td>
<td>13.09</td>
</tr>
<tr>
<td>II</td>
<td>4x1.0 m</td>
<td>7.4</td>
<td>6.5</td>
<td>8.940</td>
<td>2.590</td>
<td>40.5</td>
</tr>
<tr>
<td>Controls</td>
<td>12</td>
<td>12.3</td>
<td>11.6</td>
<td>12.810</td>
<td>1.217</td>
<td>100.2</td>
</tr>
<tr>
<td>III</td>
<td>4x1.0 m</td>
<td>8.1</td>
<td>7.1</td>
<td>7.035</td>
<td>1.800</td>
<td>38.8</td>
</tr>
<tr>
<td>Controls</td>
<td>12</td>
<td>13.1</td>
<td>12.6</td>
<td>13.200</td>
<td>1.060</td>
<td>107.0</td>
</tr>
<tr>
<td>IV</td>
<td>4x0.7 m</td>
<td>8.2</td>
<td>6.7</td>
<td>9.060</td>
<td>2.732</td>
<td>56.2</td>
</tr>
<tr>
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<td>12</td>
<td>13.1</td>
<td>11.3</td>
<td>13.270</td>
<td>1.333</td>
<td>106.8</td>
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<td>V</td>
<td>4x0.7 m</td>
<td>7.6</td>
<td>6.8</td>
<td>3.613</td>
<td>1.000</td>
<td>19.8</td>
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<tr>
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<td>12</td>
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<td>12.5</td>
<td>10.070</td>
<td>0.817</td>
<td>80.3</td>
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<tr>
<td>VI</td>
<td>4x0.7 m</td>
<td>7.0</td>
<td>5.9</td>
<td>5.065</td>
<td>2.040</td>
<td>23.2</td>
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<tr>
<td>Controls</td>
<td>12</td>
<td>12.9</td>
<td>10.4</td>
<td>7.800</td>
<td>0.920</td>
<td>62.2</td>
</tr>
<tr>
<td>VII</td>
<td>4x0.7 m</td>
<td>8.2</td>
<td>6.1</td>
<td>12.658</td>
<td>4.298</td>
<td>71.0</td>
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<td>12</td>
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<td>13.710</td>
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<tr>
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<td>5.7</td>
<td>8.799</td>
<td>3.432</td>
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<tr>
<td>Controls</td>
<td>12</td>
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<td>10.2</td>
<td>11.600</td>
<td>1.417</td>
<td>89.9</td>
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<tr>
<td>IX</td>
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<td>7.9</td>
<td>5.8</td>
<td>6.307</td>
<td>2.400</td>
<td>35.0</td>
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<tr>
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<td>12</td>
<td>13.1</td>
<td>10.0</td>
<td>10.930</td>
<td>1.400</td>
<td>87.6</td>
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</tbody>
</table>
about 1700–1800 per hectare at the age of 12–13. This statement is based on the mean stem volume data.

The correlation is also close between the stem number per hectare determined by the total stand stem number in the plots at the age 7 and 12 \( (N_{st=7}, N_{st=12}) \) and the percent rate of the changes in mean stem volumes \( (v_{st=7}, v_{st=12}) \) (fig. 9). The equation describing this relationship is \( y = 9049.7 \times x^{0.752b} \) \( (r^2=0.853, n=9) \). It is clear from this figure that the intensity of clearings may cause increased growth in the mean stem volume (50% reduction of stem number caused a change of 500% in the mean stem volume from the age 7 to 12).

At the age of 12 dead tree volumes in the control plots is (expressed in percent of growing stock) as follows:

- control, (2.4x1.0 m) = 3.3%,
- control, (2.4x0.7 m) = 8.6%,
- control, (1.0x1.6 m) = 10.1%.

The proportion of dead trees is increasing with the narrower spacing. In an initial spacing of 1.0x1.0 m the proportion of dead tree volume exceeded 10% of the living stock. It is again evidence, that a stem number of such quantity is not advisable for afforestation, neither is it right for the stem number of a young stand.

**CONCLUSIONS**

It has got clear from the experiments presented here, that the seedling number of afforestations with black locust may not be more than 4500–5000 pieces per hectare under the given site conditions. This stem number means a growing space of approximately 2.0–2.2 m per individual which can be attained by a row distance of 2.4 m and 0.8–1.0 m in-row-spacing. With this individual number recommended above an even stem dispersion and timely closure can be created for the successful accomplishment of afforestation-phase (up to the age of 4) not neglecting the mortality-rate either.

Based on the investigations of this topic the desirable stem number at the accomplishment of clearing phase is 1700–1800 individuals per hectare in black locust stands of III–IV yield class. According to the latest experiences if the row distance is reduced by 1 m and the in-row-spacing increased to 1.2 m, the individual development is more favourable. In such spacing the mechanical soil cultivation can be also possible as the experimental plot on the territory of Nyírőd Forest Share Company demonstrates.
REFERENCES


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