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INITIAL SPACING EFFECTS ON THE STAND STRUCTURE FACTORS IN YOUNG BLACK LOCUST (*ROBINIA PSEUDOACACIA* L.) STANDS

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The choice of the right initial spacing of stands is one of the most decisive factors for successful afforestation. It is even more important in the case of fast growing tree species grown in plantations; it is expressed in their early phase of development and in wood quality. The results of a 5-year long experiment with four treatments will be presented in this paper. The priority of an initial spacing of 1.6 × 1.0 m in the majority of quality parameters was confirmed. This treatment secured also an optimum exploitation of growing space by the young trees.
Key words: *Black locust (Robinia pseudoacacia L.), planting density, stand structure, yield*

Voľba vhodného počiatočného sponu je veľmi významným činiteľom úspešného zalesňovania. Je to ešte dôležitejšie v prípade pestovania rýchlorastúcich drevín špeciálnych v intenzívnych porastoch, platí to najmä pre prvé vývojové štádium a pre kvalitu dreva. V príspevku sú uvedené výsledky 5-ročného výskumu v štyroch variantoch. Z týchto vyplýva, že s ohľadom na kvalitatívne parametre sa najlepšie osvedčil spon 1,6 × 1,0 m. Tento variant súčasne zabezpečil aj optimálne využitie rastového priestoru.
Kľúčové slová: *agát biely (Robinia pseudoacacia L.), počiatočný (resp. zalesňovací) spon, štruktúra porastov, produkcia*

1. Introduction

The choice of planting spacing is a decisive element of the afforestation technology in Hungary (Szodfridt 1967, Veperdi 1988, Halupa, Gabnai 1990, Veperdi, Veperdi 1998 Rédei 2001, Rédei, Führer 2002). Regarding the effect of spacing in planted young stands for wood production, exact documents were lacking until purposeful experiments were not established to gain reliable proofs to facilitate the planning of an optimal system. Some of the experts argue that the traditionally accepted density of 2.4×0.7 to 0.8 m for black locust should be increased, whereas others prefer a lower density applied in hybrid poplar plantations.

We ought to draw the following main conclusions from experiments performed with diverse tree species.

In plantations of higher density:

- Generally, gross wood production is higher, initially;
- The branching of the trees is more favourable, the cleaning up of the stem ensues and the canopy closes earlier;
- Weeds are easier controlled;
- Natural selection has more chances; however
- The average stem diameter is smaller, and the development of a critical size is delayed;
- Later the silvicultural operations become more expensive, and the lower diameter of the stems may impair the revenue;
- Certain operations (e.g. tillage) are more difficult to be mechanised.

In plantations of lower density:

- Generally, gross wood production is lower, initially;
- The stems are branching more intensely, and closing of the canopy ensues later;
- Weeds become more aggressive; however
- Stem diameters increase more intensely, the felling cycle is shortened;
- Silvicultural practices are less expensive and the wood has better chances if being sold;
- Operations are easier mechanised.

The paper presents previous results achieved from one of the experiments of limited number, which has been designed to answer the question of optimum planting density for black locust. *However, these results need to be corroborated by further similar experiments on various growing sites.*

2. Materials and methods

2.1. Site and method of the study

The experiment was established at the beginning in autumn of 2000 at Nyírerdő State Forest Company (Nyíregyháza), at the Forestry of Hajdúhadház, in the 16 Q forest sub compartment. The growing site represented the type of forest-steppe regarding its climatic parameters; the sandy soil with medium tilt was not threatened by excessive moisture.

Four spacing treatments were planned with three replications:

- Treatment 1: 2.5×0.7 m = stem number planned: 5 700 trees/ha
- Treatment 2: 2.5×0.5 m = stem number planned: 8 000 trees /ha
- Treatment 3: 1.6×1.0 m = stem number planned: 6 250 trees /ha
- Treatment 4: 1.6×0.4 m = stem number planned: 15 630 trees /ha

Treatment 1 is the most frequently used spacing, whereas the treatment 2 was the highest density being ever applied in the practice. Treatment 3 is closely similar to treatment 1 except the space being more favourably exploited for an individual tree. Treatment 4 was an attempt to exaggerate the adverse effects of excessively high planting densities.

The measurements started after five years measuring two plots per each replication. Within the plot, the stem diameter at breast height and the height of tree has been registered on each 5th plant. The living stock (V) has been determined by means of the program developed by the Forest Research Institute (ERTI) for expressing the wood volume; the mean tree volume (v) is computed according to the relation:

$$v = V/N$$

where
N – stem number per hectare.

The growing space (number of stems per hectare) is dependent on other stand structure factors therefore its modelling is approached by different ways. In our present analysis, the most used growing space index (GSI) has been applied:

$$GSI = \frac{\sqrt{10000/N}}{H}$$

where
N – stem number per hectare; H – the mean height of trees of the stand (m).

The GSI values obtained in the experiment have been the following:

- Treatment 1: 0.29
- Treatment 2: 0.21
- Treatment 3: 0.30
- Treatment 4: 0.15

For example for the application of the GSI parameter, we take the height H = 8 m, GSI = 0.25 as the first opportunity to reduce the number of stems. The stem number of the main part of the stand (after carrying out the tending operation) will be: N = 10 000/(8×0.25) 2 = 2500 trees/ha.

Taking the scale of 1 to 4 (1 being the best, 4 the weakest), which should represent the quality and value of the stands (stand quality-index).

We did not compute measures of central tendency (mean, median etc.) and dispersion (variance, standard deviation etc.) of the different stand structure factors because the calculated values still would not be suitable for evaluating the later-expected correlations existing between them.

3. Results

The means of data obtained are presented in Table 1. The evaluation of results allows following statements. The stem number in the 5-year-old stands showed remarkable deviations from the originally planned stem number, which is expressed in percent, and it was highest (77%) in the treatment of 1.6×1.0 m, whereas in the other treatments they were more or less equal (64% – 69%).

At the age of 5, the variation of increment caused by the treatments was not essential regarding the diameter at breast height and tree height. The effect of natural selection due to high plant densities was of moderate practical significance as expressed in the mentioned properties.

Growing stock (referred to the whole stand) varied together with the planting densities, which means that the higher densities meant initially higher growing stock.

Table 1. Means of stand structure and yield factors in the experiment of 5-year-old black locust stands planted at different spacing. (Hajdúhadház 16 Q forest sub compartment).

		Designation of treatments			
		1.	**2.**	**3.**	**4.**
		Planned spacing (m)			
		2.5×0.7	**2.5×0.5**	**1.6×1.0**	**1.6×0.4**
Factors					
Stem number per hectare					
– planned (rounded up) (N_1)	Trees	5 700	8 000	6 250	15 650
– counted at the 5th year (N_2)		3 640	5 550	4 820	10 800
Ratio of N_2/N_1	%	64	69	77	69
Height (H)	m	5.7	6.3	6.4	6.4
Diameter at breast height ($d_{1,3}$)	cm	4.2	4.0	4.1	3.5
Living stock (V)	m³/ha	30.1	37.2	38.3	49.5
Dead wood (V_d)	m³/ha	0.6	0.9	0.5	1.6
Periodic total volume (V_t)	m³/ha	30.7	38.1	38.8	51.1
Mean tree volume (v)	dm³/tree	8.3	6.7	7.9	4.6
Growing space-index (GSI)					
– Before the cleaning	%	0.29	0.21	0.23	0.15
– After the cleaning	%	0.35	0.29	0.30	0.25
Stand quality-index		2.1	2.2	1.9	2.4

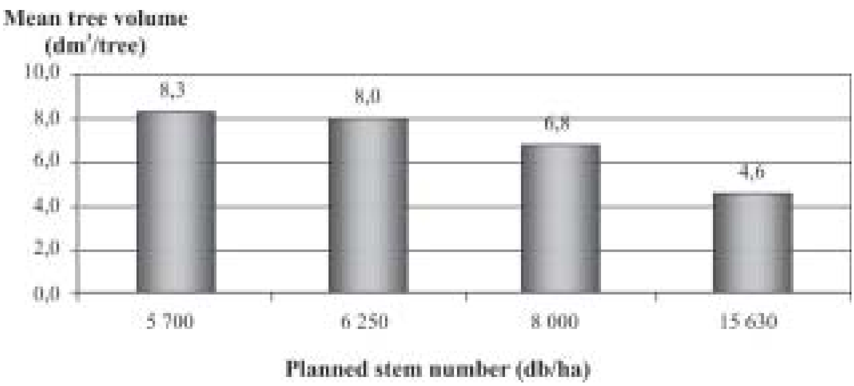

Fig. 1. Variation of the mean tree volume as a function of planned stem number.

The dead wood followed the tendency of wood volumes. As expected, the tendency was reversed if the densities are plotted against the mean volumes of individual trees, the latter being lower in dense plantings (Figure 1). In our experiment, the mean tree volume was larger in the treatment 2.5×0.7 m and 1.6×1.0 m in the 5th year by 180%

and 172% compared with the treatment 1.6×0.4 m (100%). This fact corroborates the common technological principle that in black locust plantations the density should not exceed ± 6,000 trees per hectare.

The growing space index (GSI) values – calculated according to the formula indicated – varied between 0.15 and 0.29 in the whole stand, whereas in the main part of the stand (after the first cleaning) between 0.25 and 0.35. The optimum value should be around 0.30.

The stand quality-index varied between 1.9 and 2.4, and declined with increasing planting density, as a rule.

4. Conclusions

We may state that the best results were obtained – regarding the rate of tree survival, consequently the drying rate, moreover the height, the diameter at breast height and the quality indices of the stands – *in the treatment of 1.6×1.0 m planting density.* This density secured better exploitation of the growing space relatively to the treatment 2.4×0.7 m, whereas the stem quality was better (cleaning up of branches) due to small distance between rows. All technological conditions of introducing this optimal treatment at Nyírerdő State Forest Company are given.

Regular experiments for the purpose of finding the right planting density for the main stand forming tree species grown for wood production are of prime practical importance. Information of that type is indispensable to improve the technologies of cultivation.

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Resumé

Vplyv sponov na vývoj porastov agáta bieleho (*Robinia pseudoacacia* L.) má veľký význam najmä na rast a objemovú produkciu týchto porastov. Keďže sa tejto problematike nevenovala vo

výskume až doteraz dostatočná pozornosť bolo potrebné riešiť túto problematiku aj vo výskume.

V príspevku sú hodnotené výsledky výskumu aplikácie rozličných sponov pri zakladaní porastov agáta bieleho v 5. roku po ich založení. Séria hodnotených výskumných plôch pozostáva zo štyroch čiastkových plôch, ktoré boli založené v sponoch 2,5×0,7 m, 2,5×0,5 m, 1,6×1,0 m a 1,6×0,4 m, a to v troch opakovaniach. Číselné výsledky hodnotenia výskumu sa uvádzajú v tabuľke 1 a na obrázku 1. Z týchto údajov vyplýva, že najlepší výškový rast mal agát biely pri sponoch 1,6×1,0 m a 1,6×0,4 m, najlepší hrúbkový rast pri 2,5×0,7 m a 1,6×1,0 m, kým najvyššiu celkovú objemovú produkciu pri sponoch 1,6×0,4 m a 1,6×1,0 m. Celkové hodnotenie sponov teda ukázalo, že z uvedených variantov sa najlepšie osvedčil spon 1,6×1,0 m. Okrem toho najlepšie kvalitatívne hodnotenie dosiahol tiež spon 1,6×1,0 m z hodnotových čísiel 1,9×2,4, pri ktorom najnižšie číslo znamená maximálnu hodnotu – číselné ohodnotenie 1,9. Súčasne sa porovnávali výsledky, ktoré sa dosiahli pri sponoch 2,5×0,7 m a dospelo sa k záveru, že menšia vzdialenosť medzi radmi topoľov mala priaznivý vplyv najmä na akosť kmeňov, kým väčšia vzdialenosť medzi jednotlivými stromami v radoch priaznivo ovplyvňovala využitie rastového priestoru pri spone 1,6×1,0 m.

Z výsledkov hodnotenia výskumu vyplýva, že v daných ekologických podmienkach Maďarska nie je odôvodnené používať pri zakladaní agátových porastov väčší počet jedincov ako 6 000 ks na 1 hektár. Súčasne sa ukázalo, že so zreteľom na mladý vek hodnotených objektov je potrebné vo výskume pokračovať, čo môže v značnej miere prispieť k zdokonaleniu technológií pestovania porastov agáta bieleho.