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Canadian Forest Service

CANADIAN WOOD FIBRE CENTRE

Fibre Facts n° 21

Managing Plantation Density for Red Pine: 60-Year-Old Spacing Trial Experiment

The challenge for foresters in managing Red Pine lies in finding the right tree spacing to optimize the use of site resources for stand productivity and health. An experiment in 60 year-old Red Pine plantations shows that thinning allowed for the harvest of fibre that would otherwise have been lost to mortality. Evidence of this capture of mortality was particularly strong in stands with narrower initial planting spacings. The conclusions, based on long-term data, offer advantages for management decision-making compared to approaches based on observations of unmanaged stands.

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Since the 1920s, red pine has been planted extensively in the northern United States and southeastern Canada. It grows relatively rapidly compared with most North American tree species and has the potential for high value products, particularly utility poles. The species is effective in the rehabilitation of sites degraded after decades of farming activities.

A red pine spacing trial experiment established in 1953 near the Petawawa Research Forest (PRF) in Chalk River, Ontario, Canada, provides valuable results to help foresters make decisions for optimal planting density and thinning strategies. The experiment includes combinations of six initial planting spacings (from 1.2 to 3.0 m) and the presence

or absence of commercial thinning. The thinning was applied in 1982, 1992, 2002 and 2013, each time with the aim of reducing basal area to $37.9 \text{ m}^2 \text{ ha}^{-1}$. Thinning was generally from below except where row thinning was required in the first entry to allow space for equipment.

Researchers with the Canadian Wood Fibre Centre studied the main and interacting long-term effects of initial planting density and commercial thinning treatments on tree and stand level development in the experiment. The conclusions, based on long-term re-measured data, offer advantages for management decision-making compared to approaches based on observations of unmanaged stands with associated assumptions.



Figure 1. Permanent sample plot in a thinned 65-year-old red pine stand with a 1.8 m × 1.8 m initial planting spacing.



Figure 2. 2018 imagery of the red pine plantation experimental units. (Imagery provided by Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry)

Results

At age 60, after the latest commercial thinning in the fall of 2013, results indicated the following interactions between initial planting spacing and thinning:

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Basal Area and Tree Size

- Average top height was 27 m for all plots. Basal area averaged $65.3 \text{ m}^2 \text{ ha}^{-1}$ within the unthinned plots and $37.9 \text{ m}^2 \text{ ha}^{-1}$ in the thinned plots.
- Tree size generally increased with wider initial spacing. Larger trees were observed in thinned stands.

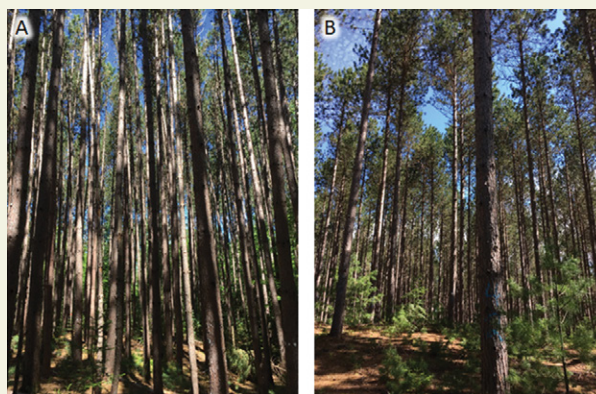


Figure 3. Examples of (A) unthinned and (B) thinned experimental units in 2018 (age 65) (Thiffault et al. 2021).

Quadratic Mean Diameter (QMD - the diameter of a tree representing the mean basal area of the stand)

- The range of QMD across planting spacings was larger for unthinned stands than thinned stands.
- The greatest responses in QMD were at the narrower spacings, suggesting a stronger effect of thinning at higher planting densities.
- Much of the thinning effect can be attributed to “the chainsaw effect”. That is, the immediate increase in mean tree size resulting from the practice of thinning from below that removes the smallest trees.

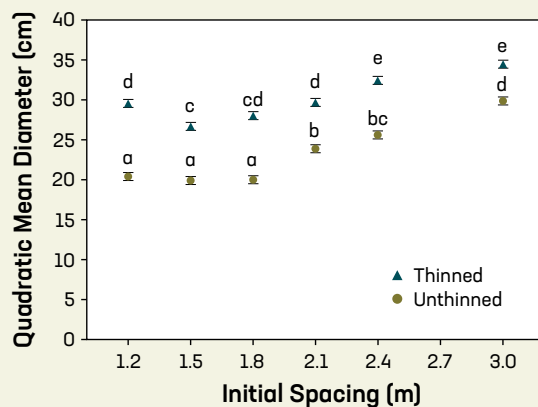


Figure 4. Interacting effect of initial planting density and a commercial thinning on quadratic mean diameter (Thiffault et al. 2021).

Total Standing Volume

- The unthinned stands peaked in the 2.1–2.4 m spacings with a mean total volume of 918.3 m³ ha⁻¹.
- Total standing volume was lower in the thinned stands and did not differ significantly among all spacing treatments with a mean of 454.5 m³ ha⁻¹.

Merchantable Volume

- Was higher in unthinned stands than in thinned stands with the highest volumes found in the 2.1–3.0 m spacings.
- Merchantable volume in thinned stands was consistent across spacing treatments.

Net Volume Production

- Greater net volume production in thinned stands with the narrower spacings confirmed that mortality was captured. Thinning effectively reduced mortality.
- On average, 10.9 m³ ha⁻¹ across the initial spacings were lost to mortality between 1982 and 2013 in thinned stands.
- Mortality volume in the unthinned stands was as high as 247 m³ ha⁻¹ in the 1.2 m spacing and became relatively close to levels in thinned stands in the 2.4–3.0 m spacings.
- Lower gross and net production for larger spacings suggested that thinning to the standard 37.9 m² ha⁻¹ resulted in under-utilized growing space.

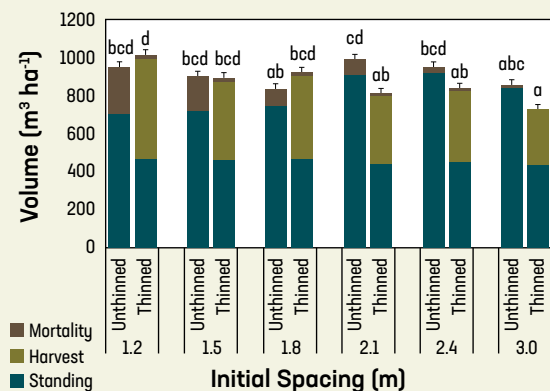


Figure 5. Interacting effect of initial planting density and a commercial thinning on cumulative gross yield (Thiffault et al. 2021).

Conclusions

Thinning allowed for the harvest of fibre that would otherwise have been lost to mortality. This capture of mortality was noted particularly in the stands with narrower initial planting spacings. A thinning effect was stronger at higher planting densities, as expressed by QMD. The larger the spacing, the less effective the thinning, as expressed by lower gross and net production, suggesting under-utilized growing space. The 2.4 m spacing was optimal in terms of tree size and total volume production among the spacings tested. The results will aid forest management decisions, especially when combined with economic considerations of silviculture costs and product prices. The dataset from this study holds further potential to support management decisions.



For more information (References):

Thiffault, N., Hoepting, M.K., Fera, J., Lussier, J.M., and Larocque, G.R. 2021. Managing plantation density through initial spacing and commercial thinning: Yield results from a 60-year-old red pine spacing trial experiment. *Can. J. For. Res.* 51(2): 181-189. doi: 10.1139/cjfr-2020-0246.

Freely accessible on the web at
<https://cdnsiencepub.com/doi/full/10.1139/cjfr-2020-0246>.

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