Morphological and Physiological Responses of Deciduous Trees to Plantation Thinning

PURDUE UNIVERSITY

Martin-Michel Gauthier and Douglass F. Jacobs

Hardwood Tree Improvement and Regeneration Center, Department of Forestry and Natural Resources
Purdue University, West Lafayette, Indiana, USA. Email: mgauthi@purdue.edu djacobs@purdue.edu

Funding for this project is provided by the Hardwood Tree Improvement and Regeneration Center at Purdue University, West Lafayette, Indiana

Abstract

Morphological and physiological responses of northern red oak (*Quercus rubra* L.), white oak (*Q. alba* L.), and black walnut (*Juglans nigra* L.) were evaluated for the first growing season after plantation thinning. Results showed that thinning increased soil water content and temperature, net photosynthesis rates, and diameter growth of residual trees when compared to trees in control plots. These findings suggest thinning increases resources to the tree, which can allocate more photosynthate toward secondary growth.

Introduction

Pure and mixed plantations composed of fine deciduous species can produce trees of considerable economic value [1]. These plantations will decline in growth and quality in the absence of management using thinning treatments. To improve our ability to better predict response after thinning and adjust silvicultural guidelines accordingly, there is a need to understand the biological means by which certain species respond to a change in environmental conditions.

Objectives

When compared to trees in control plots, we hypothesized that thinning increases (1) soil water content and soil temperature to residual trees; (2) net photosynthesis rates and leaf water potential; (3) diameter and height growth.

Methods

A 14-year-old deciduous plantation located in West Lafayette, Indiana was selected for study. Four square plots (400 m^2) were established, each consisting of a potential total of 64 trees. Two plots were thinned to 55% residual density while dormant and two were left as control plots.

A soil moisture and temperature probe was installed in each plot for the growing season. Net photosynthesis rates (*A*) and leaf water potential were measured twice per month from June to August. Height and diameter at breast height (DBH) were measured prior to thinning and after the first growing season. Plots and box charts were made to identify general trends in the data.

Results

Objective 1

Mean daily soil water content and temperature were 0.19 ± 0.01 $m^3\ m^{-3}$ and 26.3 ± 0.3 °C in thinned plots compared to 0.13 ± 0.01 $m^3\ m^{-3}$ and 22.9 ± 0.2 °C in control plots (Figures 1 and 2).

Objective 2

Net photosynthesis rates (*A*) were higher in thinned plots for all species during the three-month period (Figure 3). No trends were detected with leaf water potential.

Objective 3

Trends showed height growth in control plots was higher for all three species (Figure 4), but diameter growth was higher in thinned plots (Figure 5).

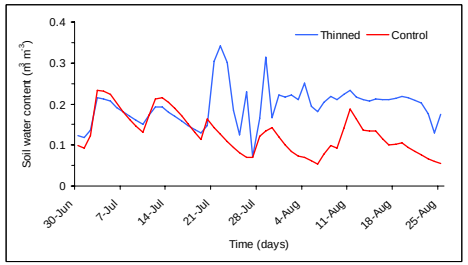

Figure 1. Mean daily soil water content in thinned and control plots one growing season after thinning.

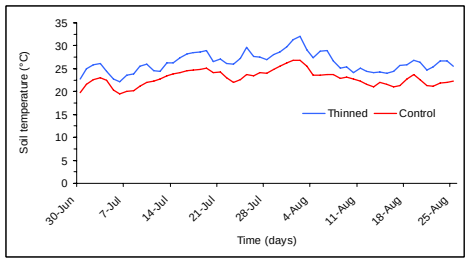

Figure 2. Mean daily soil temperature in thinned and control plots one growing season after thinning.

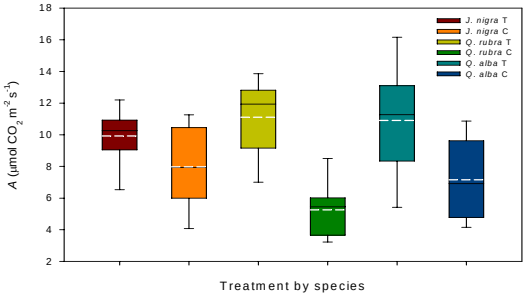

Figure 3. Box chart of net photosynthesis rates (*A*) by treatment and species one growing season after thinning (Mean: - - -, T=Thinned, C=Control).

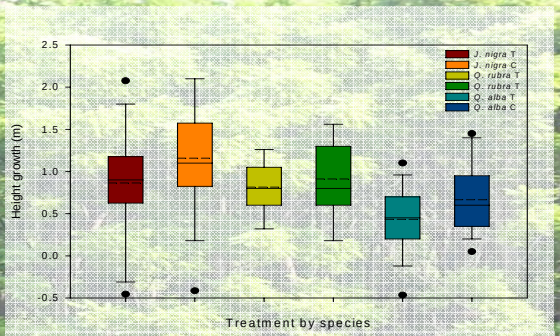

Figure 4. Box chart of height growth by treatment and species after one growing season (Mean: - - -, T=Thinned, C=Control).

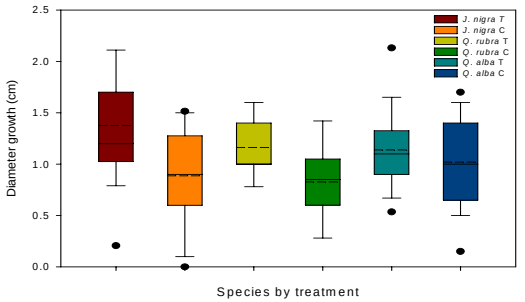

Figure 5. Box chart of diameter growth by treatment and species after one growing season (Mean: - - -, T=Thinned, C=Control).

Discussion and Conclusions

Results one growing season after treatment show that thinning increases soil water content, temperature, and net photosynthesis rates of residual trees. This is in agreement with previous thinning studies [2, 3, 4]. Increased production of photosynthate allowed trees in thinned plots to allocate more resources toward secondary growth [5].

Acknowledgements

We thank Dr. Richard Meilan, Dr. Phillip Pope, and Dr. John A. Kershaw Jr. for their help regarding this study. We also thank Eli Lilly and Company for allowing access to the study site.

References

[1] Piva, R.J. and J. Gallion. 2000. Indiana timber industry – An assessment of timber product output and use. USDA For. Serv. North Central Res. Stn. Resource Bulletin NC-216.

[2] Aussenac, G. 2000. Interactions between forest stands and microclimate: ecophysiological aspects and consequences for silviculture. Ann. For. Sci. 57: 287-301.

[3] Bréda, N., A. Granier and G. Aussenac. 1995. Effects of thinning on soil and tree water relations, transpiration, and growth in an oak forest (*Quercus petraea* (Matt.) Liebl.). Tree Phys. 15: 295-306.

[4] Wang, J.R., S.W. Simard and J.P. Kimmins. 1995. Physiological responses of paper birch to thinning in British Columbia. For. Ecol. Manage. 73: 177-184.

[5] Oliver, C.D. and B.C. Larson. 1996. Forest Stand Dynamics. Update Edition. John Wiley & Sons, Inc. USA.