

QUERCUS RUBRA PURE AND MIXED PLANTATIONS PERFORMANCE GROWING IN A NONNATIVE HABITAT

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PURPOSE AND SCOPE

Red oak (*Quercus rubra*) is an ecologically and economically important forest tree native to North America, with a presumably high climate tolerance (Nicolescu et al. 2020). Its valuable multipurpose timber also used in cabinetmaking (Massafrá 2002), shows promising productive potential in Chile due to its growth, trunk form, and health status. Mixed plantations including companion species have been shown to enhance timber quality and productivity of several species (Pretzsch and Schütze 2016). Performance of *Q. rubra* under different associations is mostly unknown. The goal of this study was to assess growth, health, and timber quality of red oak trees growing in monoculture and several mixtures including trees or shrubs as companion species.

METHODS AND APPROACH

Growth measurements were taken periodically in pure and mixed plantations established in 2001 in Los Lagos, southern Chile, for a 22-year period after planting. The tested mixtures were a main species mixture (Mix1: *Castanea sativa*, *Quercus rubra*, *Quercus robur*, and *Prunus avium*); three mixtures including main forest species plus one arboreal companion (Mix2: Mix1 + *Alnus glutinosa*; Mix3: Mix1 + *Gevuina avellana*; Mix4: Mix1 + *Embothrium coccineum*); one including main forest species plus the shrub (Mix5: Mix1 + *Fabiana imbricata*); and three mixtures including one of the arboreal companion species and the shrub (Mix6: Mix2 + *Fabiana imbricata*; Mix7: Mix3 + *Fabiana imbricata*; Mix8: Mix4 + *Fabiana imbricata*). Timber quality and health status variables were assessed at age 22. Growth variables were analyzed using linear mixed models to assess plantation effect over time. Quality timber variables were analyzed with a χ^2 test. Kaplan-Meier survival analysis and a log rank test ($\alpha = 0.05$) were used to compare red oak tree survival among treatments.

FINDINGS AND IMPLICATIONS

Results showed that *Q. rubra* trees grew well in all plantation types, with average sizes of 14.5 m in height and 22.3 cm in diameter at breast height (d.b.h.) at age

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22. Treatment effect was statistically significant for d.b.h. only at age 22, and for height starting from age 11. Across years, treatment effect on d.b.h. and height were significant ($P < 0.0001$ and $P = 0.0087$, respectively); however, none of the treatments showed a marked benefit for red oak tree growth. Treatment by age interactions were significant only for d.b.h. ($P = 0.0011$).

At age 22, red oak trees in the monoculture showed the best performance in d.b.h., being 16.2 percent higher than average values of all mixtures. For height, Mix3 and Mix6 showed the best performance, superior to the monoculture (7.5 percent higher), and to the other tested mixtures (12.2 percent higher).

Regarding timber quality variables, no differences were found among plantation types ($P > 0.05$). However, four mixtures had 100 percent vigorous trees (Mix2, Mix3, Mix4, Mix5); one mixture had 100 percent of monopodial trees (Mix7); and two mixtures showed a superior percentage of straight trees (Mix3, Mix7). No pests or diseases were recorded on any red oak tree.

Results of the log rank test applied to the survival curves estimated for red oak trees revealed no statistical differences among plantation types ($\chi^2 = 10.622$, $P = 0.2241$). However, at age 22, survival of red oaks in the pure plantation was the lowest (72.2 percent), and the average value under associations was 92.7 percent. Four associations had 100 percent survival (Mix1, Mix2, Mix3, and Mix8).

The biplot of the two principal components by plantation type, growth, and timber quality variables, explained 70.1 percent of the variability (fig. 1); it shows that Mix3, including the four main species and the arboreal companion *Gevuina avellana*, was the plantation type with the highest growth and better stem form. Results suggest that the impact of associating red oak trees on growth and timber quality was not totally evidenced at age 22.

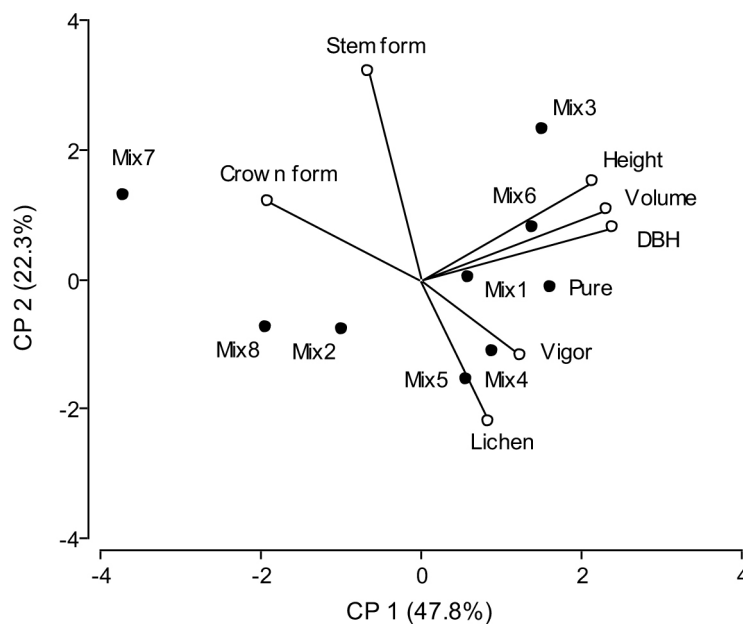


Figure 1— Biplot of the principal component analysis by plantation type, growth and quality timber variables.

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ACKNOWLEDGMENTS

The authors thank the program “Development and contributions for the use of high value forest and fruit-forest species for Chile” (INFOR-Chilean Ministry of Agriculture), and ANID BASAL FB210015 (CENAMAD) for funding the study.