SILVICULTURAL METHODS FOR *QUERCUS CRISPULA* REGENERATED IN SCARIFIED SITES: EFFECTS OF INTRA AND INTERSPECIFIC COMPETITION ON 17TH YEAR OF GROWTH AND STEM QUALITY

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PURPOSE AND SCOPE

Soil scarification has been suggested to be effective in the regeneration of Japanese oak (*Quercus crispula*) (Asada et al. 2017). This treatment involves using machinery to remove dwarf bamboo (*Sasa senanensis*), which is an inhibitor of tree regeneration. If there are seed trees (shelterwood), oak can grow densely by natural regeneration, and even if there are no seed trees, some regeneration is possible by artificial seeding. In the former, intraspecific competition among oak is dominant because other tree species have limited growth under the canopy. In the latter, interspecific competition with naturally regenerated birch (*Betula*) species becomes stronger. When growing oak for timber production, nursery practices that consider growth and tree shape are necessary. However, the growth of oak in scarified areas is not well understood. Competition with the neighbors has a tradeoff effect of reducing growth but also improving tree shape. We expected that these competitive effects would differ between under and out-of-canopy. Therefore, we scarified stands with and without seed trees, and seeded acorns for the latter. We aimed to clarify the effects of intra and interspecific competition, and to investigate appropriate silvicultural practices for Japanese oak.

METHODS AND APPROACH

This study was conducted in the Uryu Experimental Forest, Field Science Center for Northern Biosphere, Hokkaido University, Japan. In 2006, we scarified both an area with seed trees (canopy stand) and an area without them (open stand), and artificially seeded acorns in the latter. Circular plots (10 m^2 x 9 plots) were set in both stands. In 2023, the 17th year after scarification, the height and diameter of the trees in the plots were measured and their tree shapes were evaluated. In addition, sample trees of Japanese oak and Erman's birch (*B. ermanii*), a major competitor, were extracted from the plots for tree-stem analysis to examine biomass and past growth processes. The sky openness of the plots was also measured in 2023.

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FINDINGS AND IMPLICATIONS

In the 17th year, the mean (±1 standard deviation) height and diameter at breast height of oak were 2.8 m (±1.0) and 14.4 mm (±9.0), respectively, in the open stand and 2.5 m (±0.9) and 11.7 mm (±7.5) in the canopy stand, respectively. Oak trees in the open stand tended to be larger, but their height growth had been suppressed since about the 10th year (fig. 1). No such trend was observed in the canopy stand. The mean basal area sum (BA) of the open stand was 184.9 cm^2/m^2 (±112.8), including 56.8 cm^2/m^2 (±31.5) for oak and 128.1 cm^2/m^2 (±102.8) for birch, which overtopped the oak. The canopy stand (BA = 39.3 cm^2/m^2 [±32.2]) was dominated by oak (BA = 29.2 cm^2/m^2 [±23.3]) and placed birch (BA = 10.9 cm^2/m^2 [±8.2]) mainly in the understory. The BA of oak was positively related to the sky openness in each of the two stands. The trees in the open stand had a higher forking height, and lower number and volume of branches.

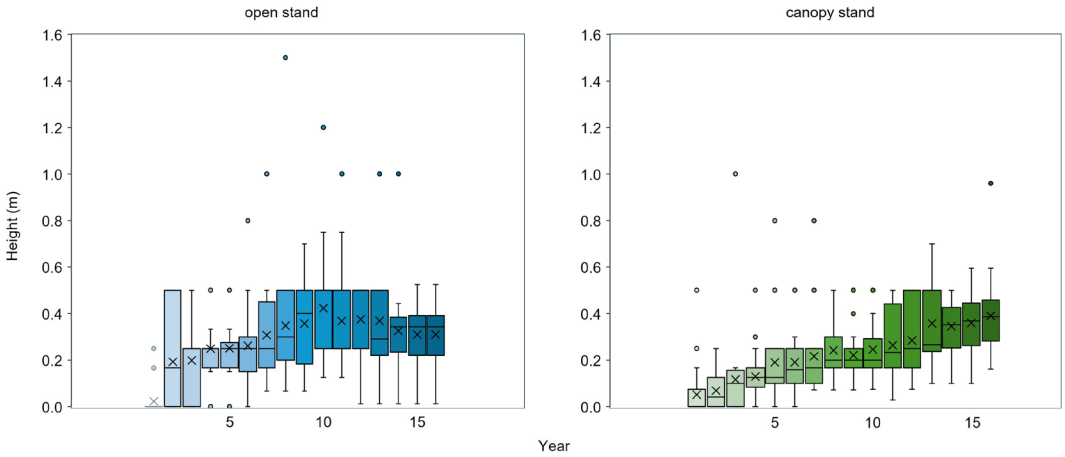

Figure 1—Annual height growth of Japanese oak over 17 years in (left) open and (right) canopy stands. The horizontal line in each box represents the median, the lower and upper ends of the box are the first and third quartiles, respectively. The two ends of the bars indicate the maximum and minimum values within 1.5 times the length of the box, and the circles indicate outliers.

These results seemed to be related to the fact that intra and interspecific competition are dominant under and outside the canopy, respectively. The strong suppressive effect of the latter suggests that the open stand requires immediate thinning of the dominant birch. The smaller tree size in the canopy stand is thought to be due to the presence of seed trees (shelterwood). Considering the lack of growth reduction in recent years and the maintenance of tree shape in this stand, removal of these seed trees is a high priority at this time, rather than thinning the conspecific neighbors.

LITERATURE CITED

Asada, I.; Yamazaki, H.; Yoshida, T. 2017. Spatial patterns of oak (*Quercus crispula*) regeneration on scarification site around a conspecific overstory tree. Forest Ecology and Management. 393: 81–88. https://doi.org/10.1016/j.foreco.2017.03.011.

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