EFFECTS OF UNDERSTORY CONTROL ON SURVIVAL AND VIGOR OF RED OAK SEEDLINGS BENEATH A SHELTERWOOD[1,2]

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INTRODUCTION

Slow growth of oak seedlings compared to growth of competing vegetation is generally recognized as a major cause of oak regeneration failures. Clearcuts often fail to regenerate to oak because established vegetation responds more readily to abundant light and moisture than young, natural oak seedlings or transplants (Loftis 1979, McGee and Loftis 1986). Recent regeneration trials in Missouri have shown that a high density shelterwood may stimulate the vigor of planted oak seedlings without giving an undue competitive advantage to other species (Johnson 1984). Silvicultural prescriptions based on these findings have been formulated for the Missouri Ozarks (Johnson et al. 1986).

The labor and expense of intensive oak regeneration practices may be an obstacle in areas where most woodlots are held by small, private landowners. This study was designed to determine if adequate oak regeneration can be obtained when only some of the recommended cultural treatments are made. This approach includes the option of relying wholly or in part on natural regeneration of oak. The present paper presents two-year results from shelterwood-herbicide-underplanting trials on two sites in the Kickapoo Valley of southwest Wisconsin.

STUDY AREAS AND METHODS

Both study areas are located on sites of above-average productivity with mature stands in which oak species comprise > 50% of the overstory basal area. The first site, near an intermittent stream (Harris Creek), is located on a lower east-facing slope with deep, silt loam soil, and has a site index of about 70 for red oak. The second site, near Warner Creek, is situated on a middle WNW-facing slope with a deep, colluvial sandy loam soil. The Warner Creek site is somewhat drier than the Harris Creek site (site index about 62), but is capable of producing good quality red oak sawtimber.

Treatments applied at each site were: (1) foliar application of glyphosate (Roundup) herbicide to all low vegetation (≤ 1.5 m tall) in late summer 1985; (2) shelterwood cut to 70% residual crown cover, with cutting of all understory trees > 1.0 m tall and treatment of stumps with Tordon RTU to prevent resprouting (winter-spring 1986); and (3) underplanting of 1-0 red oak bare-root nursery stock at a density of 2470/ha in the spring of 1986. Seedlings had been undercut in the nursery but not shoot-pruned. At the time of planting, mean basal shoot diameter was 5.9 mm and mean shoot length was 34.7 cm. All possible combinations of treatments, including controls for each treatment, were tested in a replicated split-split plot experimental design.

Percentage ground area covered by herbs, shrubs, and tree seedlings was measured in May, July, and September of each year with a Plexiglas grid mounted in a wood frame. Height measurements on planted seedlings were made in early August. Numbers of first-order branches and numbers of leaves were also recorded as an indicator of oak seedling vigor.

RESULTS

Treatment Effects on Low Vegetation

Groundcover herbicide treatment and shelterwood cutting had opposite effects on the subsequent density of low vegetation. In summer and fall of 1986, glyphosate treatment decreased cover of low vegetation 81% compared to controls while cutting increased cover by 15%. Plots that were both cut and herbicided had 37% less coverage by low vegetation than controls. In the second year after treatment, herbicide effects had diminished considerably. Herbicided plots had from 10-23% less coverage of low vegetation than unherbicided plots at Harris Creek, and 37-44% less at Warner Creek. At Harris Creek, the herbicide effect was significant only in the fall, while herbicide effects at the drier Warner Creek site were still significant in all seasons.

Oak Seedling Survival

At the end of the second growing season following treatment, survival of planted oak seedlings ranged from 73-85% on uncut plots and > 95% on cut plots on both sites. Herbicide treatment of the low vegetation, however, had no significant effect on planted seedling survival.

In the first year after treatment, cut-herbicided plots had substantially higher densities of natural red oak seedlings than control plots, although the difference was statistically significant only at the moister Harris Creek site. While densities of natural seedlings declined on all plots between the first and second year, the attrition rate was lower on cut plots. At Harris Creek in the fall of 1987, there were 3730 natural red oak seedlings/ha on the cut-herbicided plots and 869/ha on control plots. At Warner Creek, there were 1470 natural

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red oak seedlings/ha on cut-herbicided plots and 430/ha on control plots.

Growth and Vigor of Oak Seedlings

Shoot growth of planted seedlings in 1986 averaged 11.5 cm at Harris Creek and 8.9 cm at Warner Creek. Shoot growth in the first year was not affected by treatment, perhaps because of the effect of uniform nursery conditions on planting stock in the preceding year. In the second year, shoot growth on cut plots at Harris Creek was significantly greater than growth on uncut plots (9.0 vs. 4.7 cm, $P < 0.01$). Planted seedlings on cut plots at Warner Creek also grew more than those on uncut plots (5.5 vs. 3.8 cm), but the difference was not statistically significant ($P = 0.16$). Height growth of planted seedlings was not consistently affected by herbicide treatment of low vegetation at either site. The total heights of natural red oak seedlings, which averaged 15.6 cm at Harris Creek and 14.3 cm at Warner Creek in 1987, were not affected by either cutting or herbicide treatment of low vegetation.

Cutting generally had a beneficial effect on seedling vigor as measured by number of first-order branches or number of leaves per seedling. Planted seedlings on cut plots in 1987 had 53% and 70% more first-order branches than those on uncut plots at Harris Creek and Warner Creek, respectively ($P \leq 0.02$). At Warner Creek, where low vegetation was not very dense, cutting also had a significant effect on the average number of leaves for natural seedlings (5.5 on cut, 3.5 on uncut, $P = 0.03$). At Harris Creek, cutting did not affect number of leaves on natural seedlings, probably because they were mostly overtopped by the dense herbaceous vegetation. Numbers of branches or leaves were not affected by herbicide treatment for either natural or planted seedlings on either site.

CONCLUSIONS

Overstory reduction to 70% crown cover and removal of suppressed understory trees had significant positive effects on the survival, growth, and vigor of planted oak seedlings. As was found by Johnson (1984), height growth of planted seedlings under the shelterwood is modest, but development of the root system and adjustment to the site is probably more important at this stage than increase in height.

The least intensive treatments investigated in this study were underplanting in an undisturbed stand, and foliar herbicide treatment of ground vegetation in uncut stands. It may be too early to determine if underplanting by itself is a viable option. But after 2 years, seedlings under a full canopy do not appear to be vigorous, and 15-27% have already died. Herbicide treatment of the low vegetation by itself or in combination with cutting had little effect on growth or vigor of seedlings. Thus, under the present circumstances, special efforts to control vegetation < 1.0 m high do not appear to be warranted. However, it is possible that herbicide treatment of spring flora might have been more beneficial, and the reduction of small tree saplings on herbicided plots may have long-term benefits after the shelterwood overstory is removed.

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