SIX-YEAR EFFECT OF MIDSTORY REMOVAL ON WHITE OAK GROWTH AND BIOMASS DISTRIBUTION AND SEEDLING RESPONSE ONE YEAR POST-CLIPPING

Jared M. Craig, John M. Lhotka, and Jeffrey W. Stringer[1]

Increasing abundance of shade tolerant trees in oak- (*Quercus* spp.) dominated forests has led to enhanced concern regarding the recruitment of oak into the overstory following disturbance. The key to future oak success is through developing large advance reproduction. One proposed method with demonstrated success is midstory removal. This technique increases light to the understory, which may allow oak to gain a competitive advantage over shade-tolerant species (Lockhart and others 2000, Lorimer and others 1994, Parrott and others 2012). Basal shoot clipping has also been suggested as a way to develop more vigorous oak seedlings (Lockhart and others 2000). What is still unknown, however, is what effect a midstory removal treatment has on oak seedling biomass and whether any increases in size provide an advantage to seedlings following clipping. Our first objective was to document biomass accumulation and allocation trends of white oak (*Q. alba* L.) advance reproduction 6 years following midstory removal. We also examined the effect of basal shoot clipping 6 years following midstory removal on white oak sprout growth through one growing season.

The study was established in three stands of intermediate site quality (average site index of 19.5 m) located on Berea College Forest in Madison County, KY. Stand overstories were primarily composed of oak and hickory (*Carya* spp.), while understories were dominated by red maple (*Acer rubrum* L.) and American beech (*Fagus grandifolia* Ehrh.). In 2005, two 0.4-ha plots were established at each site, and the plots were randomly assigned midstory removal and control treatments. The midstory removal treatment reduced basal area by 20 percent and removed overtopped and intermediate crown class trees. Pretreatment data indicated that oak seedling size did not differ between treatments, and mean oak seedling height and ground line diameter (gld) were 9.7 cm and 3.0 mm, respectively.

Six years after midstory removal, 30 white oak seedlings were selected from each plot, and height and gld were recorded. Seedling leaf area was estimated using midrib length and leaf area relationships presented in Parrott and others (2012). In the winter prior to the seventh growing season, the selected white oak seedlings were clipped at their base using hand shears. Seedling tops were oven dried and weighted to determine above-ground biomass. Eighty additional white oak seedlings were excavated, and oven-dried root weights from these seedlings were used to develop allometric root biomass equations. Equations were then applied to height and gld data from the clipped seedlings to estimate below-ground biomass. One growing season after basal clipping, height and gld of the seedling sprouts were measured.

Results indicate that midstory removal significantly increased white oak seedling size and above- and below-ground biomass accumulation after six growing seasons (table 1). Stem and root biomass were more than three times larger in the midstory removal treatment than in the control. However, biomass allocation fractions between stem and root did not differ between treatments. The sprout probability following basal clipping was similar between the midstory removal (86 percent) and control (85 percent) treatments. Sprout height and gld one growing season following basal clipping was significantly larger in the midstory removal treatment than in the control (table 1). However, no treatment effect was found for the relative growth response by clipped seedlings. Among treatments, 66 percent of pre-clipping height and 60 percent of pre-clipping gld were achieved one growing season following clipping.

[1]Forester, Ohio Department of Natural Resources, Shawnee State Forest, Portsmouth, OH 45663; and Assistant Professor and Professor, respectively, University of Kentucky, Department of Forestry, Lexington, KY 40546.

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Table 1--Mean (±SE) comparisons between control and midstory removal treatments for white oak seedling measurements with associated t-test p-values

Variable	Control	Midstory removal	p-value
Six-year seedling characteristics (pre-clipping)			
Height (cm)	24.30 ± 1.17	36.00 ± 2.30	<0.001
Ground line diameter (mm)	2.99 ± 0.14	4.87 ± 0.30	<0.001
Total leaf area (cm^2)	239.30 ± 56.74	1087.10 ± 229.20	<0.001
Above-ground biomass (g)	1.39 ± 0.21	6.02 ± 1.35	0.008
Below-ground biomass (g)	4.20 ± 0.44	13.13 ± 2.05	<0.001
Total biomass (g)	5.21 ± 0.65	18.46 ± 2.92	<0.001
Seedling characteristics 1 year post-clipping			
Sprout height (cm)	15.20 ± 0.75	21.33 ± 1.33	<0.001
Sprout ground line diameter (mm)	1.75 ± 0.10	2.68 ± 0.17	<0.001

Study findings suggest that midstory removal increased biomass accumulation of white oak advance reproduction but did not alter the allocation of biomass between above- and below-ground portions. Results also suggest that short-term response to basal clipping was linked to seedling size and not conditions inherent to the midstory removal treatment. Although results are from one growing season following clipping, it appears that the combination of midstory removal and subsequent basal clipping may aid in promoting larger white oak advance reproduction. Subsequent monitoring will provide insight into the long-term response of clipped seedlings developing in the two treatments evaluated by this study.

LITERATURE CITED

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