ROTATION-LENGTH EFFECTS OF DIVERSE LEVELS OF COMPETITION CONTROL AND PRE-COMMERCIAL THINNING ON STAND DEVELOPMENT AND FINANCIAL PERFORMANCE OF LOBLOLLY PINE IN CENTRAL LOUISIANA

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Long-term productivity of loblolly pine (*Pinus taeda L.*) plantations can be increased by early suppression of herbaceous and woody competing vegetation (Zutter and others 1986, Haywood 1994, Miller and others 2003a). The USDA Forest Service's Competition Omission Monitoring Project (COMP) was designed to isolate influences of two major competition groups (herbaceous and woody plants) at a range of sites in the Southeast U.S. A broad array of results from the COMP study improved understanding of loblolly pine growth (Miller and others 1991, 1995a, 1995b, 2003a), soil and foliage nutrients (Miller and others 2006), and understory and mid-story vegetation development (Miller and others 2003b). The potential for intensive early competition control to induce earlier onset of intraspecific competition and the differences between loblolly pine growth and development in response to more operational, one-time applications of herbicides relative to the sustained herbaceous and woody suppression of the COMP study treatments have received less attention. This study was designed to complement the COMP study by adding treatments that consisted of several operational mixtures of herbicides and pre-commercial thinning to the COMP study treatments.

The study was conducted at the USDA Forest Service Kisatchie National Forest in central Louisiana, near the town of Winnfield. The site's soil was classified as USDA Natural Resource Conservation Service Bellwood series, which is a poorly-drained loam. The site was planted with loblolly pine in December 1984 at 640 trees per acre following a mechanical site preparation in May 1984 and site preparation burn in October 1984. In July 2002, the entire site was commercially thinned to 160 trees per acre.

The following herbicide treatments were conducted at the site: (1) CONTROL, (2) HERB-COMP, (3) WOOD-COMP, (4) TOTAL-COMP, (5) LOTOT-OP, (6) MEDTOT-OP, and (7) HITOT-OP. The CONTROL treatment received no herbicide. Three treatments were COMP study treatments conducted annually from 1985 through 1989 as described by Miller and others (2003b). The HERB-COMP treatment was a suppression of herbaceous vegetation, the WOOD-COMP treatment was a suppression of woody vegetation, and the TOTAL-COMP treatment consisted of control of herbaceous and woody vegetation.

Three herbicide treatments (LOTOT-OP, MEDTOT-OP, HITOT-OP) were relatively low-, medium-, and high-cost herbicide mixtures conducted to approximate an operational, one-time application of herbicides that would provide suppression of herbaceous and woody vegetation. Woody vegetation control herbicides for the operational treatments were applied prior to planting in 1984. For the LOTOT-OP treatment, a mixture of picloram and triclopyr at 1.5 and 0.5 gallons per acre, respectively, was used for woody vegetation control. Woody vegetation control of the MEDTOT-OP treatment was conducted with a mixture of a blended formula of 2,4 D and dicamba and triclopyr at 1.0 and 0.13 gallons per acre, respectively. The HITOT-OP treatment consisted of hexazinone applied at 3.0 gallons per acre for woody vegetation control. Herbaceous vegetation control herbicides for the operational treatments were applied in 1985; all operational treatments had a mixture of sulfometuron methyl and sethoxydim at 4.0 oz. per acre and 1.5 pt. per acre, respectively, for herbaceous vegetation control. Four replications of all treatments were conducted; experimental units were 0.25-acre plots.

In 1991, a pre-commercial thinning treatment was superimposed as a split-plot treatment across all treatments. Two levels of a pre-commercial split-plot treatment were conducted: no pre-commercial thinning,

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and pre-commercial thinning to 300 trees per acre. Pre-commercial thinning was conducted by chainsaw-felling trees.

In 1987, 1991, 1994, 1999, 2001, 2005, and 2013, stand basal area was measured for all plots to determine treatment effects on stand-level growth. To determine the financial performance of all treatments, net present value, land expectation value, and estimated annual income were determined for all treatment combinations at a 5 percent interest rate. Silvicultural costs used in the financial analysis were drawn from Southeast U.S. silviculture cost surveys (Dooley and Barlow 2013). Revenue estimates in the financial analysis were derived from values of pulpwood, chip-and-saw, and sawtimber from the 2002 thinning and for standing timber value in 2013 (Louisiana Department of Agriculture and Forestry 2014).

There were significant herbicide and pre-commercial thinning effects on stand basal area. There were differences among herbicide treatments in all years observed except 2005 (fig. 1A). The TOTAL-COMP treatment had the highest basal area and the CONTROL treatment had the lowest basal area of all treatments in 1991. The TOTAL-COMP and CONTROL treatments had among the highest and lowest basal areas, respectively, of all treatments in all years in which significant

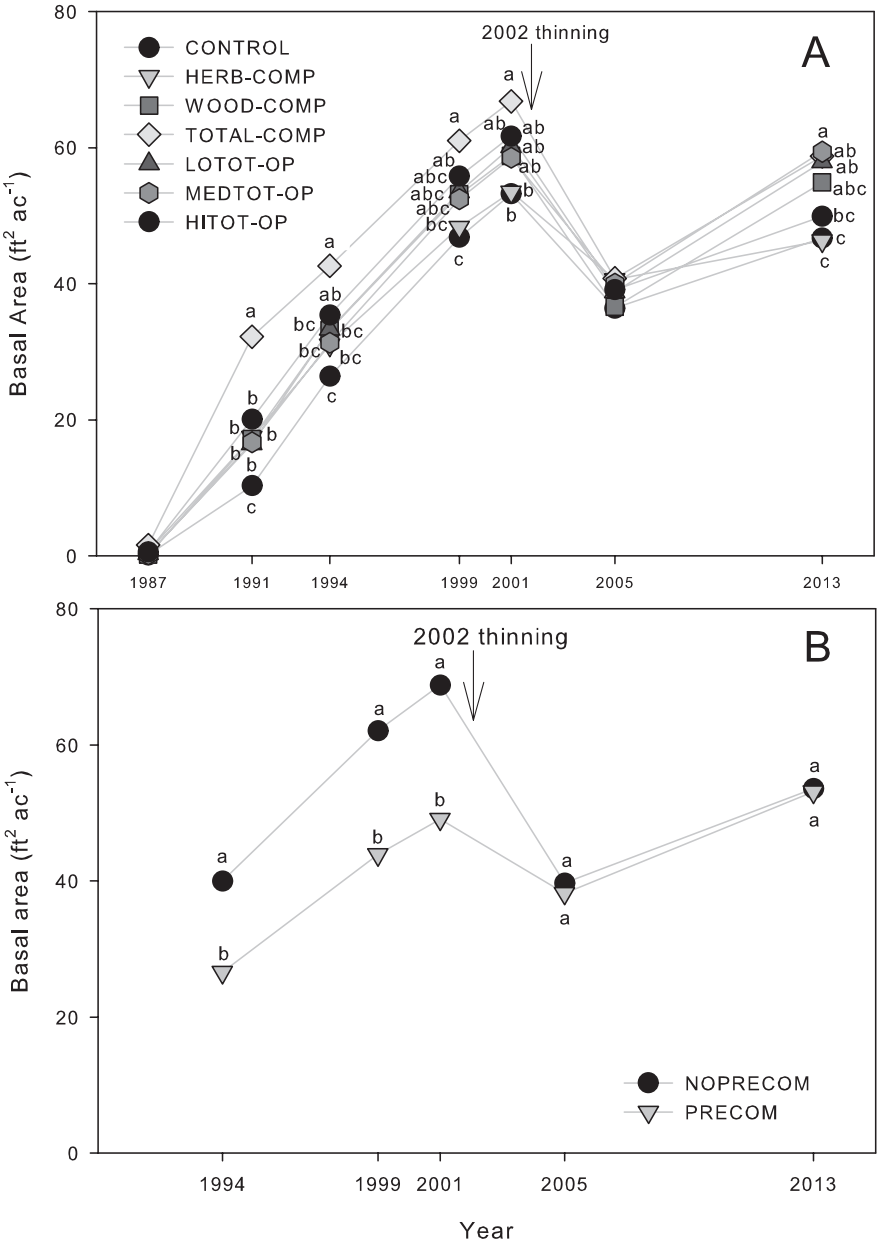

Figure 1—Stand basal area in response to (A) early-rotation herbicide treatments and (B) pre-commercial thinning treatments in a loblolly pine plantation in central Louisiana. For each year, treatment symbols noted with different letters differ at $P < 0.05$.

differences were observed. Pre-commercial thinning led to greater stand basal area in all years observed (fig. 1B). Among all treatment combinations, the HERB-COMP treatment with pre-commercial thinning had the highest net present value, land expectation value, and estimated annual income at the 5 percent interest rate tested (table 1). These findings suggest that intensive herbaceous vegetation control provided the greatest productivity benefit for the expense. Furthermore, although pre-commercial thinning increased silvicultural costs its long-term growth benefit enhanced financial performance. A management implication for these results is that early-rotation stand density is an important consideration when intensive vegetation control is conducted, with lower early-rotation stand density likely preferable in order to reduce lost productivity to intraspecific competition.

LITERATURE CITED

Dooley, E.; Barlow, R. 2013. Costs and cost trends of southern forestry practices in 2012. Alabama Cooperative Extension System Bulletin FOR-2001. Auburn, AL: Alabama Cooperative Extension System. [Not paged].

Haywood, J.D. 1994. Tenth-year results of herbaceous weed control in a loblolly pine plantation. Southern Journal of Applied Forestry. 18(3): 105-109.

Louisiana Department of Agriculture and Forestry. 2014. Louisiana pulpwood and timber production report. Available online at: www.ldaf.louisiana.gov/portal/Offices/Forestry/ForestryReports/tabid/449/Default.aspx [Date accessed: March 14, 2015].

Miller, J.H.; Zutter, B.R.; Zedaker, S.M. [and others]. 1991. A regional study on the influence of woody and herbaceous competition on early loblolly pine growth. Southern Journal of Applied Forestry. 15(4): 169-179.

Miller, J.H.; Zutter, B.R.; Zedaker, S.M. [and others]. 1995a. Early plant succession in loblolly pine plantations as affected by vegetation management. Southern Journal of Applied Forestry. 19(3): 109-126.

Miller, J.H.; Zutter, B.R.; Zedaker, S.M. [and others]. 1995b. A regional framework of early growth response for loblolly pine relative to herbaceous, woody, and complete competition control: the COMP project. Gen. Tech. Rep. SO-117. New Orleans, LA: U.S. Department of Agriculture Forest Service, Southern Research Experiment Station. 48 p.

Miller, J.H.; Zutter, B.R.; Zedaker, S.M. [and others]. 2003a. Growth and yield relative to competition for loblolly pine plantations to midrotation: a southeastern United States regional study. Southern Journal of Applied Forestry. 27(4): 237-252.

Miller, J.H.; Zutter, B.R.; Newbold, R.A. [and others]. 2003b. Stand dynamics and plant associates of loblolly pine plantations to midrotation after early intensive vegetation management: a southeastern United States regional study. Southern Journal of Applied Forestry. 27(4): 1-16.

Miller, J.H.; Allen, H.L.; Zutter, B.R. [and others]. 2006. Soil and pine foliage nutrient responses 15 years after competing-vegetation control and their correlation with growth for 13 loblolly pine plantations in the southern United States. Canadian Journal of Forest Research. 36: 2412-2425.

Zutter, B.R.; Glover, G.R.; Gjerstad, D.H. 1986. Effects of herbaceous weed control using herbicides on a young loblolly pine plantation. Forest Science. 32(4): 882-899.

Table 1—Net present value (NPV), land expectation value (LEV), and estimated annual income (EAI) at a 5% interest rate for a 29-year rotation in response to herbicide and pre-commercial thinning treatments at a site in central Louisiana

Treatment	NPV	LEV	EAI
No Pre-commercial thinning			
Control	3877.3	1167.2	58.4
Herb-comp	3640.0	1095.7	54.8
Wood-comp	2302.5	693.1	34.7
Total-comp	3967.6	1194.4	59.7
Otot-op	4840.3	1457.1	72.9
Medtot-op	5092.6	1533.0	76.7
Hitot-op	5048.9	1519.9	76.0
Pre-commercial thinning			
Control	4795.7	1443.7	72.2
Herb-comp	5440.1	1637.6	81.9
Wood-comp	-667.9	-201.0	-10.1
Total-comp	-60.0	-18.1	-0.9
Lotot-op	4104.4	1234.6	47.2
Medtot-op	3133.5	943.3	67.1
Hitot-op	3310.6	996.6	49.8