2002

Growth Reponse of Loblolly Pine to Intermediate Treatment of Fire, Herbicide, and Fertilizer: Preliminary Results

L. M. Marino
Stephen F Austin State University

B. P. Oswald
Stephen F Austin State University, boswald@sfasu.edu

K. W. Farrish
Stephen F Austin State University, kfarrish@sfasu.edu

H. M. Williams
Stephen F Austin State University, hwilliams@sfasu.edu

Daniel R. Unger
Stephen F Austin State University, unger@sfasu.edu

GROWTH RESPONSE OF LOBLOLLY PINE TO INTERMEDIATE TREATMENT OF FIRE, HERBICIDE, AND FERTILIZER: PRELIMINARY RESULTS

L.M. Marino, B.P. Oswald, K.W. Farrish, H.M. Williams, and Daniel R. Unger[1]

Abstract—Crown area is an important factor in determining stem development. This study examined the changes in stem diameter per unit area of crown due to treatment with fire, herbicide, fertilizer, and tree-thinning practice. The experimental sites were mid-rotation loblolly pine (*Pinus taeda*) plantations that were thinned one year before treatment. Site 1 was strictly row-thinned and Site 2 was thinned by and within each row. Five replicates were installed on each site. Each replicate consisted of 8 subplots (0.1 ha) containing a central 0.04 ha measurement plot. A randomized-block split-plot design was used at each site, with fertilizer as the whole-plot factor and vegetation control treatment as the subplot factor. The herbicide treatment (approximately 4.5 L ha^{-1} Chopper®, 2.5 L ha^{-1} Accord®, 11.2 L ha^{-1} Sun-It II oil, and 76.7 L ha^{-1} water) was applied in October, 1999. Prescribed burning was performed in March, 2000, and fertilizer (224 kg ha^{-1} N and 28 kg ha^{-1} P) was applied in April following the burn. The height and diameter of each tree was measured at plot establishment (1999) and in December, 2000. Individual tree crown area was measured in June, 2000. A leaves-to-tree (LT) metric, defined as the ratio of a tree's diameter (cm) in December, 2000 to crown area (m^2) in June, 2000 was used to examine the impact of the various factors. Herbicide affected growth differently at the two sites; growth was increased at Site 1, but decreased at Site 2, relative to their respective controls. The results were unaffected by the use of fertilizer. Fire had a negligible effect on growth at both sites, with and without fertilizer. Herbicide and fire were additive at Site 2 but antagonistic at Site 1. The results suggest that thinning practices can significantly alter the impact of herbicides and fire on tree growth. Data from the second (and final) year of the study will be available in December, 2001.

INTRODUCTION

Crown dimension measurements are commonly used to study habitat for wildlife, encroachment rates into tree gaps, and many other aspects of tree growth (Fajvan and Grushecky 1996, Vales and Bunnell 1988, Zeide and Gresham 1991). Larger crown area often translates into more photosynthetic surface area, which can increase stem development. Many factors can affect crown size, including silvicultural treatments, thinning (Smith and others 1997), chemical control of woody competitors (Ezell and others 1997), prescribed fire (Wade and Johansen, 1986), and fertilization (Williams and Farrish 1994).

Crown growth represents the biological basis for the desired outcomes of increased tree growth and optimal use of limited space. However, few studies have systematically examined the impacts of fire, herbicide, fertilizer, and thinning practice on individual tree growth. This is a preliminary report of such a study in mid-rotational loblolly pine in East Texas.

METHODS

Study Sites

The study area consisted of two sites on land owned by International Paper Company in northeastern Texas. Both sites were thinned in 1998, 1 year before plot establishment. Site 1 was hand-planted on 1.8 m by 3.1 m spacing, and row-thinned and thinned within the rows to a basal area of 13 m^2 per ha before plot establishment. Soils were of the Darco, Teneha, and Osier series; slopes ranged from 3-15 percent. The site index was 65 at base age 25 years.

Site 2 was machine-planted on 1.8 m by 3.7 m spacing, and row-thinned to a basal area of 22 m^2/ha one year before plot establishment. Soils were of the Ruston and Attoyac series, with slopes ranging from 3-15 percent. The site index was 71 at base age 25 years.

Five replicates at both sites were established in 1999. Each replicate consisted of 8 treatment subplots (40 plots per site)each 0.10 ha in size. A central 0.04 ha

[1]Ph.D Student, Associate Professors, Assistant Professor, Arthur Temple College of Forestry,Stephen F. Austin State University, Nacogdoches, TX, respectively.

Citation for proceedings: Outcalt, Kenneth W., ed. 2002. Proceedings of the eleventh biennial southern silvicultural research conference. Gen. Tech. Rep. SRS–48. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 622 p.

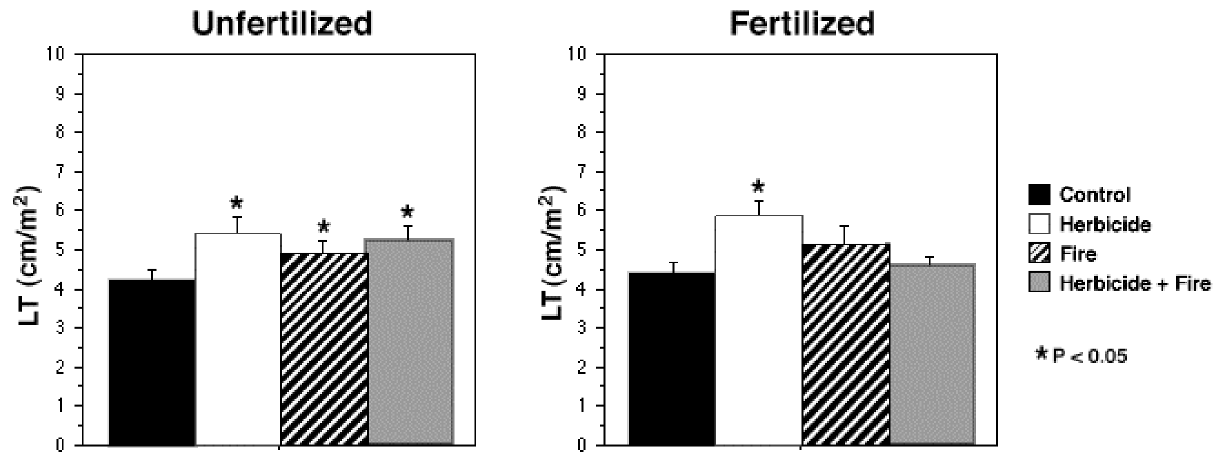

Figure 1—Effect of treatment on tree growth at Site 1, assessed using LT

measurement plot was established within each subplot. A randomized-block-split-plot design was used in which half of each replicate was randomly chosen for application of fertilizer, and each treatment (control, herbicide, prescribed fire, and herbicide/prescribed fire) was randomly assigned to the treatment subplots. A 10-m buffer separated each treatment subplot. All trees greater than 5 cm in diameter located within the subplots were tagged, identified to species, and measured for total height and DBH. There were approximately 20 and 35 trees per subplot at Sites 1 and 2, respectively.

Treatments

Due to a late summer drought, herbicide was applied in October, 1999. A herbicide mixture of 4.5 L/ha Chopper®, 2.2 L/ha Accord®, 11.2 L/ ha Sun-It® II oil, and 76.7 L /ha water was applied at Site 2. The same mixture was applied at Site 1, except that the amount of Accord® was increased to 2.5 L /ha, in an attempt to control a more dense understory. The mixtures were broadcast using a CO_2 backpack sprayer with a 3.66 m boom. Competing woody vegetation taller than 3.66 m was injected with a mixture of 100 ml Arsenal© AC diluted in 300 ml of water.

Firelines were installed around each burn plot to preserve the 10-m buffer. Prior to burning, ceramic tiles coated with strips of heat-sensitive paint (Tempilaq©) were installed at each plot center. The paint disintegrated at 100, 200, 400, 800, or 1000°C, thereby allowing for an estimate of fireline intensities. Four painted tiles per plot center were suspended from a rebar post at 4 levels: subsurface, surface, 0.3 m and 0.6 m aboveground.

The plots were prescribe-burned in March, 2000, using strip backfires. A backfire was used in an attempt to limit canopy damage due to scorch. Scorch heights (if any) were determined for each tagged tree.

In April following the burn, the fertilizer treatment was applied using a standard spreader. Diammonium

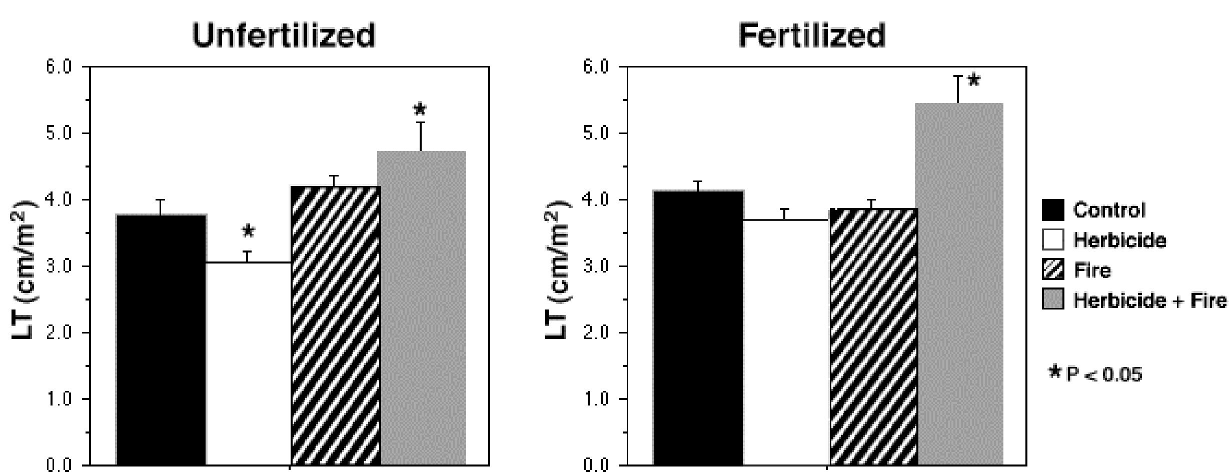

Figure 2—Effect of treatment on tree growth at Site 2, assessed using LT

phosphate (DAP) was and urea were applied at a rate of 224 kg/ ha N and 28 kg/ ha P, respectively.

Measurements

The crown area of each tree was determined in June, 2000 as follows (Farr and others 1989, Larocque and Marshall 1994, Peterson and others 1997). The length of the longest branch in each cardinal direction between the branch tip and tree stem was obtained using an electronic distance meter (Forestor Vertex, Haglof, Sweden). The area of the resulting polygon was calculated, after correcting for the radius of the tree. To ascertain the accuracy of the method, the results were compared with those calculated using 12 measurements per tree made at equal angular increments from a reference line. Use of 4 measurements consistently underestimated the crown area, but by less than 10 percent. The reproducibility of the measurement method was determined by making crown-area determinations on 10 different days, using 4 measurements per tree (5 trees). The average variation in the measurements was less than 7 percent.

The total height and outside bark DBH of each tagged tree were measured in December, 2000.

Study Metric and Statistical Analysis

To study the effect on tree growth of vegetative control (fire and herbicide), fertilizer, and thinning practice, it was necessary to control for any differences in tree diameter that existed prior to commencing the experiment. This was accomplished using a leaves-to-tree (LT) metric defined and calculated as follows. For each tree, the diameter (in cm) measured in December, 2000 was divided by the corresponding crown area (in m^2) measured in June, 2000. LT was, therefore, a simple measure of growth that related the diameter of the tree to its crown area measured 6 months earlier. The aim of the study was to determine how LT was affected by the study factors. For simplicity in interpretation, this was done on the basis of simple comparisons. Because LT was not normally distributed, differences were analyzed using the Mann-Whitney U test.

RESULTS AND DISCUSSION

At Site 1, herbicide treatment significantly increased growth, as assessed using LT (figure 1). The effect of fire was marginal, and it antagonized the effect of herbicide when the two treatments were combined (figure 1). Similar results occurred in both fertilized and unfertilized plots.

At Site 2, treatment with fire plus herbicide produced a significant increase in LT on both unfertilized and fertilized plots (figure 2). Either treatment alone had no beneficial effect.

Significant inter-site differences were seen in the response of the trees per unit of crown area to vegetative control. The differences could be due to the different thinning methods used at each site. Alternatively, they could be due to the slightly higher productivity at Site 1. the effect of thinning was likely more important because the addition of fertilizer had essentially no effect at either site.

There are at least two reasons that could explain why the prescribed fire was not as successful as herbicide treatment in promoting growth at Site 1. First, the dense understory was more easily controlled with the herbicide because the herbicides were selected specifically for control of the competing species actually present. In contrast, fire is known to affect some competing species more than others. Second, the relative humidity was 58 percent on the day the fire was applied. This could have reduced consumption of the competing vegetation. Analysis of post-burn fuel loading and temperature data may provide insight into the question.

Further Work

LT will be determined using stem diameters measured in December, 2001, thereby allowing assessment of the study hypotheses in the context of stem growth that occurred over a 2-year period. Stem maps and nearest-neighbor analysis will be used to examine individual tree growth response to treatment. Basal area growth and height growth will also be determined. This study is part of a larger study that is examining the physiological parameters, soil effects, and biodiversity changes in response to treatment.

Researchers will collaborate in order to fully characterize the response of mid-rotation loblolly pine to treatment with fire, herbicide, and fertilizer in East Texas.

ACKNOWLEDGMENTS

The authors thank the Forest Resources Institute, Arthur Temple College of Forestry, International Paper, Dr. Jimmie Yeiser, Dr. Dean Coble, and all graduate and undergraduate student involved with field measurements.

REFERENCES

Ezell, A. W.; Nelson, L. R.; Vollmer, J.; Minouque, P. J.; Catchot, A.L. 1997. Efficacy of dormant season basal applications of imazapyr and triclopyr for controlling undesirable woody stems. In: Waldrop, T. A., ed. Proceedings of the Ninth Biennial Southern Silvicultural Research Conference; 1997 February 25-27; Clemson SC. Gen. Tech. Rep. SRS-20. Asheville, NC: U. S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 33-37.

Fajvan, M. A.; Grushecky S. T. 1996. Mapping Forest Architecture. Journal of Forestry. 94: 17-18.

Farr, W. A.; DeMars, D. J.; Dealy, J. E. 1989. Height and crown width related to diameter for open-grown western hemlock and Sitka spruce. Canadian Journal of Forest Research. 19: 1203-1207.

Laroque, G. R.; Marshall, P. L. 1994. Crown development in red pine stands. Canadian Journal of Forest Research. 24: 762-774.

Peterson, J. A.; Seiler, J. R.; Nowak, J.; Ginn, S. E.; Kreh, R. E. 1997. Growth and physiological responses of young loblolly pine stands to thinning. Forest Science. 43: 529-534.

Smith, W. R.; Farrar Jr., R. M.; Murphy, P. A.; Yeiser, J. L. 1992. Crown and basal area relationships of open-grown southern pines for modeling competition and growth. Canadian Journal of Forest Research. 22: 341-347.

Vales, D. J.; Bunnell, F. L. 1988. Comparison of methods for estimating forest overstory cover. I. Observer effects. Canadian Journal of Forest Research. 18: 606-609.

Wade, D. D.; Johansen, R. W. 1986. Effects of fire on southern herbicide application on growth and yield of older loblolly pine plantations- two year results. In: Edwards, M.B., comp. Proceedings of the Eighth biennial southern silvicultural research conference; 1994 November 1-3, Auburn, AL. Gen. Tech. Rep. SRS-1. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 505-511.

Zeide, B., Greshham, C. A. 1991. Fractal dimensions of tree crowns in three loblolly pine plantations of coastal South Carolina. Canadian Journal of Forest Research. 21: 1208-1212.