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Survival And Growth Responses Of Loblolly Pine To A Range Of Competition Control

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A spotgun equipped with a forestry nozzle (above) provides a low cost and effective method for releasing pines from weed competition (below) during their first year growth.

ABSTRACT

A study to evaluate the circular area around a planted seedling in which competing vegetation needs to be controlled to give acceptable seedling survival and growth was installed in 1986. The study was located on an upland Piedmont site in north Georgia. Treatments included: (1) no vegetation control, (2) treatment of circular areas two, four, six and eight feet in diameter with 3.5 oz ai/ac of Oust. Trees in the six- and eight-foot diameter treatments averaged 14 percent better survival and were from 55 to 67 percent greater in height after three years than trees in the check treatments. The best treatment to promote growth and survival and reduce chemical cost would appear to be the six-foot diameter spot treatment.

INTRODUCTION

Several studies have demonstrated that herbaceous weed control applied to loblolly pine plantations in year one can increase growth (Knowe et al., 1985; South and Barnett, 1986; Wittwer and Dougherty 1986). To encourage owners to use this treatment will require that the chemical and application cost be reduced as low as possible. From an environmental standpoint it is also important that only the minimum area that needs to be controlled to promote survival and growth be treated with herbicide. To determine the amount of competition free-growing space needed to insure high survival and rapid growth it is necessary that survival and growth response curves be developed as a function of the amount of competition free-growing space that is provided to a seedling. The objective of this study was to determine the size area that needs to be controlled around a seedling to optimize the cost and biological response to vegetation control using Oust.

MATERIALS AND METHODS

Study Site Description:

The study site is located in Wilkes County, Georgia. The soil on the study site is mapped as a Hiwassee series. The site was site-prepared by roll-chopping and burning in the fall of 1985. The setting was machine planted in the winter of 1986 with improved north Georgia source of 1-0 bareroot loblolly stock.

Study Design and Treatments:

The study design was a randomized complete block design. Blocking was done on the basis of slope position. A total of five blocks were included in this study. The following treatments were assigned at random to 45 feet by 85 feet plots in each block:

1) check-no herbicide applied
2) herbicide applied in a two-foot diameter circle centered on each seedling
3) herbicide applied in a four-foot diameter circle
4) herbicide applied in a six-foot diameter circle
5) herbicide applied in an eight-foot diameter circle

All herbicide treatments consisted of applying 3.5 oz. ai/ac Oust. The two through six-foot diameter treatments were applied with a Chemtrol spot gun with a forestry nozzle attachment (Spraying System Co - 4.3W Full-jet nozzle. This nozzle applies the herbicide relatively evenly over the treatment area. The eight-foot diameter treatment was accomplished by applying a six-foot diameter treatment with the spot gun and then expanding it to an eight-foot diameter circle with a backpack sprayer. Each spot gun treatment was applied in a total volume of 5 ml/spot. All applications were made on May 1, 1986.

Measurements:

Survival, height and ground-line diameter were measured at the end of the growing season in 1986, 1987, and 1988. Diameter at breast height was measured in 1988. Weather records were obtained from the Washington, Georgia weather station which is located 8 miles from the study site.

Analysis:

Standard analysis of variance using the GLM SAS procedure and Duncans multiple range test was used to determine significant differences in treatment means. An arcsin transformation was made on the percent survival data before significance tests were made.

RESULTS AND DISCUSSION

Climate Trends:

The first half of 1986 averaged 14.22 inches below normal in rainfall. However, in May, the month the herbicide was applied, 6.86 inches of rainfall was received. Thereafter, rainfall remained low until August when 5.41 inches of rain was received. In 1987 and 1988 rainfall averaged 13.2 inches and 7.6 inches, respectively, below normal for the period between April and December. Potential evapotranspiration as estimated by the Thornwaite Method (1957) exceeded rainfall for most of the summer period in all three years. Due to the lower than average rainfall, higher than average temperatures, and high evaporative demand, the growth potential for each of the three years would have been lower than expected for this site.

Trends in Seedling Mortality:

There was no significant difference in mortality observed for the check, two-foot diameter or four-foot diameter treatments (Table 1). Mortality for these three

Table 1. Average trends in mortality observed for loblolly seedling planted in the check, two-, four-, six-and eight-foot diameter weed control treatments after one, two, and three years in the field. Means in a column with different letters are statistically different at the a = .10 level.

Treatment	Mortality Year One	Mortality Year One & Two	Mortality Year One-Three
Check	22^{a}	24^{a}	25^{a}
Two Feet Diameter	24^{a}	24^{a}	24^{a}
Four Feet Diameter	21^{a}	21^{a}	21^{a}
Six Feet Diameter	12^{b}	12^{b}	12^{b}
Eight Feet in Diameter	11^{b}	11^{b}	11^{b}

Table 2. Average third year height and diameter at breast height of trees treated for weed control at the time of establishment.

Treatment	Average Height (feet)	Average Diameter at Breast Height (inches)
No weed control	5.9 ± .10	0.44 ± .02
Weed control in 2-foot dia. circles	6.0 ± .10	0.48 ± .02
Weed control in 4-foot dia. circles	6.4 ± .10	0.56 ± .02
Weed control in 6-foot dia. circles	6.9 ± .10	0.68 ± .02
Weed control in 8-foot dia. circles	7.3 ± .10	0.74 ± .02

treatments after three years in the field ranged from 24 to 25 percent. Average mortality for seedlings grown in the six- and eight-foot diameter treatments after three years was 12 and 11 percent, respectively. Average seedling mortality observed for the six- and eight-feet diameter treatments was significantly different ($\alpha = .10$) from that observed for the check, two-or four-foot diameter treatments. Almost all of the seedling mortality occurred in the first year (Table-1).

Seedling Growth: Height Response

Height growth followed the same pattern as diameter growth and survival. With the best response being obtained from the six- and eight-foot diameter treatments. Seedlings in the eight-foot diameter treatments were 20 percent taller than those in the check treatment at the end of year one. At the end of year 3, the average difference in height for these two treatments was 1.4 feet. Test of significant difference on average seedling height after three years in the field indicated that seedlings in the six- and eight-foot diameter treatments were significantly taller than seedlings in the check, two- or four-foot diameter treatments (Table 2). Trees in the six- and eight-foot diameter treatments were not significantly different in height.

Seedling Growth: Diameter Response

Average diameter at breast height (DBH - 4.5 feet) observed after three years in the field is shown in Table 2. Average DBH increased as the size of the circle of vegetation control was increased. Average DBH for the check treatment was 0.44 inches versus 0.74 inches for trees in the eight foot diameter treatment. Trees in the six foot diameter treatment had an average DBH of 0.68 inches which is 91% of that achieved with the eight foot diameter treatment. Using plot volume index as suggested by Marx and others (1977) to accounts for both survival and growth effects indicated that the cost for a percent gain in growth is about equal for the six and eight foot diameter treatments (Table 3). The eight foot diameter treatment cannot be achieved with the forestry spot gun. To achieve an equivalent eight foot treatment would require a wide strip or broadcast application. This would result in the six foot diameter treatment having the most favorable cost per percent gain estimate.

Table 3. Average diameter (DBH), height, survival, tree volume index (D^2H), plot volume index = Survival * (D^2H) and cost per one percent gain in growth (Plot volume index) for trees in the five competition control treatments after three years in the field.

Treatment Check	Cost/acre[1]	Diameter (in)	Height (ft)	Survival (Trees/ac)	Tree Volume Index (in^3)	Plot Volume Index (in^3)	Cost/1% gain in Plot. vol.
	0	.44	5.9	487	13.7	6,672	----
2′	13.65	.48	6.0	491	16.6	8,145	.62
4′	18.60	.56	6.4	515	23.8	12,233	.22
6′	26.80	.68	6.9	569	38.3	21,793	.12
8′	38.43	.74	7.3	578	48.3	27,917	.12

[1] Assumes $12.00 acre application cost for all treatment, $7.50/ounce of Oust product, and that 650 trees per acre were treated with 4.7 ounces of Oust/product/acre.

DISCUSSIONS AND CONCLUSIONS

The results of this test would indicate that at least a six-foot diameter herbicide treatment zone was needed to maximize survival and growth on an upland Piedmont site. Treating a six-foot diameter area around each seedling represents treating 42 percent of a gross acre if 650 trees are planted per acre. At a rate of 3.5 ounces active ingredient of Oust per acre (4.7 oz product) and at 7.50 dollars per ounce product, this represents a chemical cost of 14.86 dollars per acre. On most areas, five to seven acres can be treated per day with spot gun technique. At a charge of sixty dollars per man-day, application cost would be 12 dollars per acre. Thus, total cost per acre would be 26.88 dollars per acre.

The benefits from both the six- and eight-foot diameter treatments were both a 14 percent increase in survival and an increase in growth. The biological value of the 14 percent increase in survival was estimated by comparing the yields after 30 years for a stand planted with 650 trees per acre with 11 percent mortality versus one with a 25 percent initial mortality rates using the yield simulation model developed by Burgan and Bailey (1987). Based on land with a site index of 60 feet at 25 years the simulation suggests that the reduced mortality would result in 1.54 more cunits of wood produced per acre.

The impacts of the growth gains on final yields are hard to estimate. The 12 year results for loblolly reported by (Glover et al., 1989) suggest that the treatment difference in growth will continue to increase over the next few years. In the study after 3 years in the field, an absolute gain in height of about 1.0 feet was obtained due to weed control being applied in a 6-foot diameter spot. If weed control treatments as applied in this study ultimately result in an increase in average tree height of three feet (i.e., increases site index three feet) then the estimated increase in yields due to both the 14 percent increase in survival and growth would be 5.82 cunits per acre. With this treatment response and a treatment cost of 26.88 dollars per acre this represents an initial up front investment of 4.61 dollars per cunit produced. This compares with an initial investment cost of 5.53 dollars per cunit on the untreated area if site preparation and establishment is assumed to cost 150 dollars per acre. Based on this analysis it would suggest that going for the additional gains that can be made on established acres may be a better investment than planting more acres and managing less intensively. More acres mean more tax and more management cost. Weed control treatments are likely to be most beneficial on areas where survival problems are expected to develop. Areas that are hand planted following low intensive site preparation, areas that have laid out after harvesting or cropping and established pastures would be examples where survival problems might be expected to develop. For example in two studies comparing the influence of weed control on survival in established pastures in north Georgia survival of seedlings receiving weed control averaged 89 and 88 percent, whereas those receiving no weed control averaged 49 and 58 percent (Dougherty & Edwards, 1988; Edwards & Dougherty, 1988). With a greater certainty in survival initial planting densities can be reduced. This will result in additional savings due to lower seedling cost and lower planting cost.

LITERATURE CITED

Burgan, T.M. and R. L. Bailey. 1987. Georgia Pine Plantation Simulator - An interactive microcomputer program for stand structure, yield, growth and financial analysis of thinned site prepared slash and loblolly pine plantations. School of Forest R5resources, University of Georgia, Athens, GA 30602. 31 pp.

Dougherty, P.M. and M. B. Edwards. 1988. The influence of weed control on establishment of loblolly pine on a Georgia Piedmont pasture site. Proceedings: Southern Weed Science Society - 41st Annual Meeting. 1988. Tulsa, Oklahoma. p. 193-196.

Edwards, M.B. and P.M. Dougherty. 1988. Controlling bermuda grass to establish loblolly pines. Proceedings: Southern Weed Science society - 41st Annual Meeting, 1988. Tulsa, Oklahoma. p. 203-210.

Knowe, S.A., L.R. Nelson, D.H. Gjerstad, B.R. Zutter, G.R. Glover, P.J. Minouge, and J.H. Dukes, Jr. 1985. Four-year growth and development of planted loblolly pine on sites with competition control. South. J. Appl. For. 9:11-15.

Marx, DD.H., W.C. Bryan, and C.G. Cordell. 1977. Survival and growth of pine seedlings with *Pisolithus* extomycorrhizae after two years on reforestation sites in North Carolina and Florida. Forest Sci. 23:363-373.

South, D.B., and J.P. Barnett. 1986. Herbicides and planting date affect early performance of container-grown and bare-root loblolly pine seedlings in Alabama. New Forests 1:17-27.

Wittwer, R.F., P.M. Dougherty, and D. Cosby. 1986. Effects of ripping and herbicide site preparation treatments on loblolly pine seedling growth and survival. South. J. Appl. For. 10:253-257.

Thornthwaite, C.W., and J.R. Mather. 1957. Instruction and tables for computing potential evapotranspiration and water balance. Drexel Institute of Technology, Publications in Climatology, Vol. 10, No. 3. 67 pp.

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