CARIBOO FOREST REGION RESEARCH SECTION

Extension Note

"Making Research Work for You"

Extension Note #36

February 2002

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Cariboo Forest Region, BC

Effects of Thinning and Fertilizing on the Growth of 36-Year-Old Height-Repressed Lodgepole Pine

INTRODUCTION

Throughout the Fraser Plateau, located in the western half of the Cariboo Forest Region, fires have created many young, very dense lodgepole pine stands that are not expected to produce merchantable timber if left untreated. Treatment options for such stands are currently not well defined, as many of them range from 20 to 80 years of age and are well under 10 m in height. The ability of these height-repressed stands to respond to silviculture treatments has generally been considered low or nil. Furthermore, many of them have no road access, thus further limiting any foreseeable management options.

As a pioneer species, lodgepole pine relies on wildfire as a regenerating mechanism because its cones require heat to open and release seed. The capacity of this species to fully regenerate disturbed areas—to the point of producing excessively high densities that restrict tree growth—is well known. Excessive densities create high levels of competition that substantially reduce diameter growth and can also affect height growth. Over time, this intense inter-tree competition results in: (1) stem diameters that are small relative to tree height (this reduces stand density and increases the possibility of breakage from wind and snow); and (2) trees that have sparse crowns and low needle biomass (this limits the trees' ability to respond to improved growing conditions).

The Timber Investment Strategy Committee of the Cariboo Forest Region reported that more than 130,000 ha of fire-origin lodgepole pine stands required treatment if they were to be included in the productive forest landbase (Timber Investment Strategy Committee, 1996). Most of these stands are located in the SBPS biogeoclimatic zone and MSxv subzone. An estimated 5,340 ha of stands originating from wildfires before 1970 have been juvenile spaced, and a small number of similar stands have been rehabilitated and planted, or harvested for specialty products such as fence poles.

In 1997, an operational trial at the Rosita Fire was established to answer the fundamental question of how dense wildfire-origin lodgepole pine should be managed. This Extension Note provides early stand-tending results of that work (Newsome, 2002).

OBJECTIVES

The Rosita Fire trial was designed to test the effectiveness of three stand-tending and six rehabilitation treatments in improving stand productivity. Summarized here are the results of the stand-tending treatments.

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The results of the rehabilitation treatments are still too early to be reported.

The main stand-tending objective of the trial was to determine if thinning and fertilization—alone and in combination—can increase the growth of height-repressed pine. A secondary objective was to provide a demonstration site of treatments tested.

STUDY AREA

The site where the Rosita Fire occurred lies west of Williams Lake at 96 km on the Mackin Creek Forest Road, in the Williams Lake District of the Cariboo Forest Region. The trial area is located in the SBPSdc biogeoclimatic subzone on gently rolling terrain. It falls predominantly within the 01 (pine–juniper–feathermoss) site series, but also includes sub-mesic areas and small, wet depressions.

The Rosita Fire burned approximately 900 ha in the summer of 1961. Since that time, lodgepole pine has naturally regenerated on the site to different densities. Some sections are growing well (most with densities of less than 10,000 stems/ha), but others at higher densities are not. Differences in height and diameter growth due to this variability are apparent. Table 1 lists the stands' pre-treatment attributes.

Foliar analysis conducted in October 1997 before treatments were applied indicated that nitrogen levels (0.92%) were severely growth-limiting. Foliar levels of sulphate sulphur (41 ppm) and boron (5 ppm) also indicated probable sulphur and boron deficiencies.

METHODS

The Rosita Fire trial area was stratified by tree height to reduce within-block variability. This resulted in a randomized complete block design in which most treatments were replicated three times.

The stand-tending treatments consisted of thinning, fertilization of thinned and unthinned stands, and an untreated control. Thinning was conducted in the fall of 1997 to a final target density of at least 2,200 stems/ha (ranging up to 3,000 stems/ha). No minimum inter-tree distance was specified to allow for selection of the best potential crop trees. Fertilizer was applied by hand in October 1998 at a rate of 1,227 kg/ha. The fertilizer was custom blended to deliver nutrients at the following rates (kg/ha): 200-N, 100-P, 100-K, 75-S, 36-Mg, 3-B.

Rehabilitation treatments included hand-slashing all stems with a power saw in the fall of 1997, and mulching with a Hydro-Axe in 1998. Hand-slashed areas were divided into four treatment types: (1) slash left on the ground; (2) disc trench; (3) pile, slash and burn; and (4) pile, slash, burn and disc trench. The mulching treatments included Hydro-Axe only and Hydro-Axe followed by disc trenching. All rehabilitation treatments were planted in 1999 with PSB 410 lodgepole pine seedlings, half of which were fertilized with a mixture of nutrients when planted.

The stand-tending treatment plots were assessed in 1997 before fertilization and then annually the following three falls. All assessments were taken within a 30 m x 30 m monitoring plot located at the centre of 70 m x 70 m treatment plots. Two sets of data were collected: (1) measurements of 36 potential crop trees per plot were selected at evenly distributed gridpoints, and (2) measurements from all trees within separate fixed-radius plots were taken within the 30-m^2 plots. Approximately 100 trees from these plots were used to quantify the stand's overall response to treatments. First-year response to fertilization was assessed in the fall of 1999.

Due to initial variation in tree size, analysis of covariance was used to compare the growth variables.

RESULTS

Foliar concentrations of the three deficient nutrients increased for all treatments receiving fertilizer (Table 2). The highest values were found one year after fertilization, although some values never reached the recognized adequate level. By the second year after fertilization,

Table 1. Mean stand attributes and ranges at the Rosita trial area before treatment, obtained from the assessment of 27 plots

Variable	Mean	Range
Density (stems/ha)	21,167	8,000—39,250
Acceptable trees (%)	26.3	1.1—47.5
Tree Height (cm)	337.0	232.1—522.1
Diameter at breast height (cm)	2.8	1.8—4.4
Height/diameter ratio	120	119-129
Live crown (%)	27	19—38
Incidence of stem gall (%)	4.8	3.6—35.2
Incidence of needle cast (%)	77.9	54.4—87.5

all nutrient concentrations except for sulphate sulphur had dropped. Needle mass had also increased a year after fertilization, but then dropped again by the second year. At the same time, however, stem growth increased. This resulted in an overall increase in biomass, which in turn diluted the nutrient concentration. Nevertheless, despite the lower nutrient concentration, height growth was still accelerating two years after fertilization.

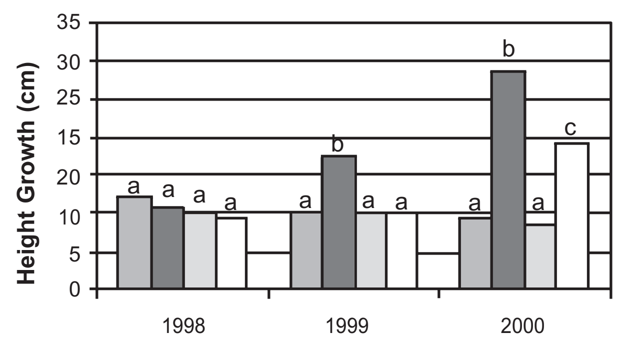
Annual height growth (or leader length) responded positively to the fertilizer treatments but not to the thinned-only treatments. After thinning, a non-significant decrease in crop tree height growth was initially observed. Fertilizer application in the fall of 1998 produced the only significant height response in 1999, in the fertilized-only treatment. By 2000, the thinned-and-fertilized treatment produced a height growth response, but the crop trees in the fertilized-only treatment were still significantly taller (Figure 1).

In the fixed-radius plots, where all trees were assessed, annual height growth did not differ significantly between any treatments in 1998 (Figure 2). Two years after fertilization, however, height growth increases were significant for the two treatments receiving fertilizer. Thinning alone had little effect on height growth.

Diameter growth of the crop trees increased with both thinning and fertilization, and the combined treatments produced significantly more growth (Table 3). However, when all the trees in the fixed-radius plots were considered, diameter growth in the fertilized-only treatment was not significantly different from that in the control.

Table 2. Foliar nutrient status for those nutrients found to be deficient in 1997

Nutrient	Adequate Level	Year	Untreated	Fertilized	Spaced	Ferilized and Spaced
Nitrogen (%)	>1.35	1999	0.81	1.22	0.89	1.31
		2000	0.88	1.10	0.94	1.15
Total Sulfur (%)	>0.10	1999	0.07	0.11	0.07	0.11
		2000	0.07	0.09	0.07	0.09
Sulphate Sulphur (ppm)	>80	1999	38	83	34	70
		2000	38	95	31	78
Boron (ppm)	>15	1999	8	31	9	33
		2000	8	26	10	26
Weight of 100 needles (g)	N/A	1999	1.19	2.54	2.05	3.23
		2000	1.30	1.78	1.59	2.30



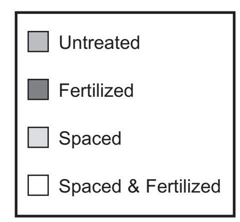


Figure 1. Annual height growth of crop trees.

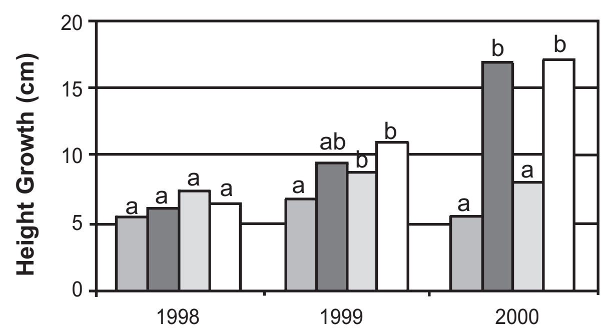


Figure 2. Annual height growth of all trees in the fixed-radius plots.

Table 3. Diameter growth response over three growing seasons (1998–2000) for (i) crop trees only and for (ii) all trees assessed within a fixed-radius plot. Those treatments followed by the same letter are not significantly different.

	Diameter (cm)			
Population Assessed	Untreated	Fertilized	Spaced	Fertilized and Spaced
Crop trees	0.36[a]	0.79[b]	0.68[b]	1.11[c]
All trees	0.25[a]	0.44[ab]	0.65[b]	0.99[c]

Figure 3. Thinned and fertilized lodgepole pine two years after treatment.

Also important to note is that while damage to trees from snow or other elements has been minimal, some bark stripping from rabbit feeding occurred on the unthinned fertilized treatment.

CONCLUSIONS

After two years, the most significant preliminary conclusion from the trial is that fertilization achieved the best height growth in 36-year-old, height-repressed lodgepole pine. Thinning alone did not bring about a height growth response, but it did produce a diameter response—one similar to that produced by fertilization. However, the combination of the two treatments was significantly better than either treatment alone. Despite reductions in nutrient concentration two years after fertilizing, height growth increases continued probably because of the increase in total foliar biomass.

The trial's early results suggest that while fertilization will at least temporarily relieve height repression in both thinned and unthinned stands, thinning will have no immediate effect on height growth.

Initial results also suggest that, if current growth rates continue, the fertilized trees can become merchantable within approximately 50 years.

FUTURE WORK

1. Continued monitoring is planned to measure the length of the observed growth responses.

2. The rehabilitation treatments will be measured and compared with the stand-tending treatments to determine whether fertilizing height-repressed lodgepole pine will produce merchantable trees faster than rehabilitation and planting.

3. There are plans to replicate the trial methods in a 60-year-old stand located in a drier subzone, the SBPSxc, in 2002.

Trial Number: SX97403

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ACKNOWLEDGEMENTS

This Extension Note is based on the project's working paper reporting third-year results (being prepared by the BC Ministry of Forests) and was written by Jane Perry and Teresa Newsome, with assistance from Rob Brockley, Guy Burdikin and Nola Daintith. Georgina Montgomery of G. Montgomery & Associates conducted the final editing and Forest Renewal BC provided funding for Extension Note development and printing.