Forest Site Management Section
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May 7, 1999

SILVICULTURE NOTE 19

FERTILIZATION AT THE TIME OF PLANTING: NINE-YEAR RESPONSE OF DOUGLAS-FIR, ENGELMANN SPRUCE AND LODGEPOLE PINE IN THE SOUTHERN INTERIOR ICH

Summary

Fertilization at planting with Gromax™ teabags did not affect survival of Douglas-fir, Engelmann spruce or lodgepole pine seedlings. Fertilized seedlings were taller and had larger stem diameters in the second year after planting, but this effect had disappeared by year five. In year nine, the proportion of seedlings that had reached free growing was similar in fertilized and unfertilized treatments. Seedlings of all three species performed better on a mesic site than a mesic-subhygric site, but the trends in response to fertilization were similar on the two sites.

Introduction

Fertilization of seedlings at planting is commonly prescribed in some areas of British Columbia, in hopes that it will reduce growth check (especially among spruce) (Brockley 1988), alleviate nutrient deficiencies, or give seedlings a head start on competing vegetation. As van den Driessche (1997) comments, however, it is a far from precise science, and seedling responses have been unpredictable. Improved growth, reduced survival, and lack of response have all been reported, possibly because of differences in fertilizer formulation, application rate, and placement. Variability in site characteristics, planting stock quality, and application of other silviculture treatments (e.g., brushing) have also affected results.

Most of the positive responses to fertilization at planting are reported within the first two to three years. However, longer term monitoring is required to determine whether fertilization influences the time to reach free growing and whether the improvements in growth are sufficient to justify costs over the long term. A summary of interim results for 20 research trials involving the use of Gromax™ fertilizer "teabags" in BC suggested that, although growth responses were generally significant in the first two to three years, after five years, fertilized seedlings averaged only 9 cm taller than unfertilized seedlings. Height was more variable among fertilized than unfertilized seedlings, and survival was lower (Bowden 1995). This memo presents nine-year results from the Tillis Landing study, which is located in the productive ICHmw3 subzone near Salmon Arm (Table 1).

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Table 1. Site characteristics at Tillis Landing

	Tillis 1	Tillis 2
BGC classification	ICHmw3/06	ICHmw3/01
Soil moisture regime	mesic-subhygric (4-5)	mesic (4)
Soil nutrient regime	rich (D)	medium (C)
Elevation	1150 m	1150 m
Slope/aspect	20%/east	15%/west
Soil type/texture	Brunisol/SiCL	Brunisol/SiCL
Coarse fragments	5–10%	15%
Root-restricting layer	40 cm	20 cm
Humus form	Hemimor	Hemimor
History	Logged 1986/87 Broadcast burned 1988	Logged 1985/86 Broadcast burned 1988

Methods

In spring 1989, Engelmann spruce (1+0 PSB 313A), Douglas-fir (1+0 PSB 313A), lodgepole pine (1+0 PSB 211A) seedlings were planted on the two sites according to three fertilization treatments (Table 2). Seedling height, leader length and stem diameter were measured in 1990, 1993 and 1998, and seedling survival was assessed also on those dates. The 1998 measurements were carried out before leader elongation was complete, so height and leader length were measured on 1997 growth.

The two sites were ecologically stratified in 1992, and it was determined that approximately one-quarter of each research area was of a different site series than the dominant one ('06' at Tillis 1 and '01' at Tillis 2). To ensure homogeneity, seedlings in the dissimilar areas were dropped from the study, and data for all years were re-analysed in 1998. These changes resulted in slightly different means for seedling size than those presented in earlier research memos concerning this project, but did not affect overall trends in the results.

Results

Two years after fertilization at planting

Two years after fertilization at planting, mean survival across treatments and locations was 90% for Douglas-fir, 98% for Engelmann spruce, and 96% for lodgepole pine. There were no significant differences in survival between fertilized and unfertilized seedlings for any of the species, nor were there differences between locations.

Engelmann spruce and lodgepole pine seedlings that had been fertilized with either one or two Gromax™ teabags were significantly taller, had longer leaders, and had larger stem diameters than unfertilized seedlings at year two (Figure 1). Fertilized Douglas-fir seedlings had significantly larger stem diameter than unfertilized seedlings, but there were no differences in height or leader length. Seedlings at Tillis 2 (mesic) were significantly larger than those at Tillis 1 (mesic-subhygric). There were no significant differences in the effects of one versus two Gromax™ teabags.

Table 2. Treatments

Treatment	Formulation†	Fertilizer per tree (g)	N†† per tree (g)	P†† per tree (g)	K†† per tree (g)	Release period‡
Control						
Gromax1	12-5-8	5	0.60	0.25	0.40	24 month
Gromax2	12-5-8	10	1.20	0.50	0.80	24 month

† Each Gromax™ teabag also included 2 g hydrophilic gel, intended to increase the water holding capacity around the seedling.
†† N-source was 6.4% NH_4 and 5.6% NO_3; P-source was P_2O_5; K-source was K_2O.
‡ The manufacturer's suggested release period was 360–420 days under standardized temperature and moisture conditions. Under field conditions it was expected to be longer.

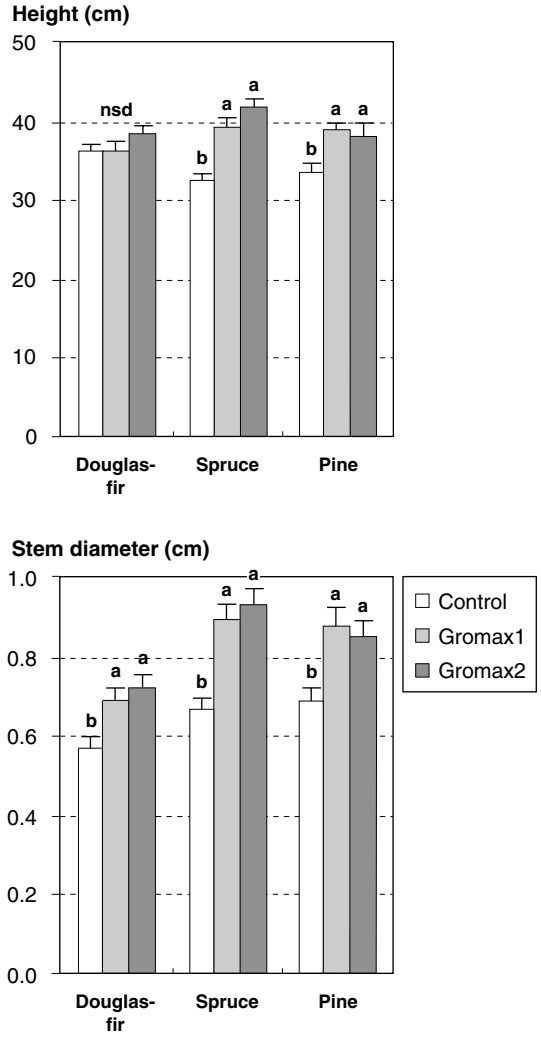

Figure 1. Height and stem diameter of seedlings two years after fertilization at planting (locations combined). *Error bars are one standard error, and bars with similar letters are not significantly different.*

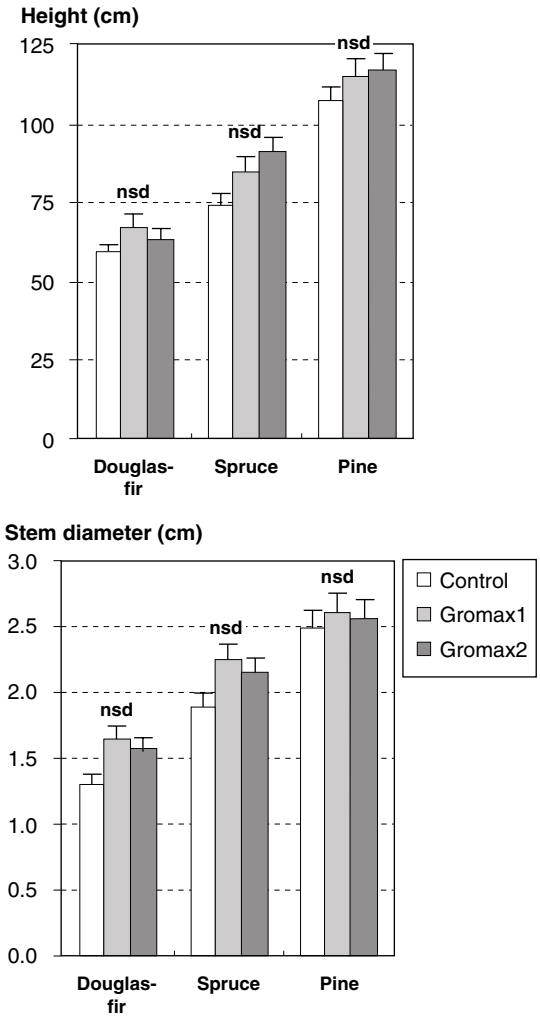

Figure 2. Height and stem diameter of seedlings five years after fertilization at planting (locations combined). *Error bars are one standard error, and bars with similar letters are not significantly different.*

Five years after fertilization at planting

Five years after fertilization at planting, mean survival across treatments and locations was 74% for Douglas-fir, 95% for Engelmann spruce, and 91% for lodgepole pine. There were no significant differences in survival between fertilized and unfertilized seedlings for any of the species, and no differences between locations.

In year five, there were no significant differences in height, leader length or stem diameter between fertilized and unfertilized seedlings among any of the three species (Figure 2). Seedlings at Tillis 2 continued to be significantly larger than those at Tillis 1.

Nine years after fertilization at planting

Nine years after fertilization at planting, mean survival across treatments and locations was 64% for Douglas-fir, 93% for Engelmann spruce, and 84% for lodgepole pine. There were no significant differences in survival between fertilized and unfertilized seedlings for any of the species, and no differences between locations.

In year nine, there were no significant differences in height, leader length or stem diameter among Douglas-fir and Engelmann spruce seedlings that had been fertilized and those that had not (Figure 3). Lodgepole pine seedlings in the Gromax1 treatment were taller and had larger stem diameters than unfertilized seedlings in the control and those in the Gromax2 treatment, but it is unclear whether this effect is related to the fertilization treatment, since the

initial growth response had subsided by year five. Fertilization had no effect on the proportion of Douglas-fir, spruce or pine seedlings that had reached free growing by year nine, but seedlings at Tillis 2 continued to be significantly larger than those at Tillis 1.

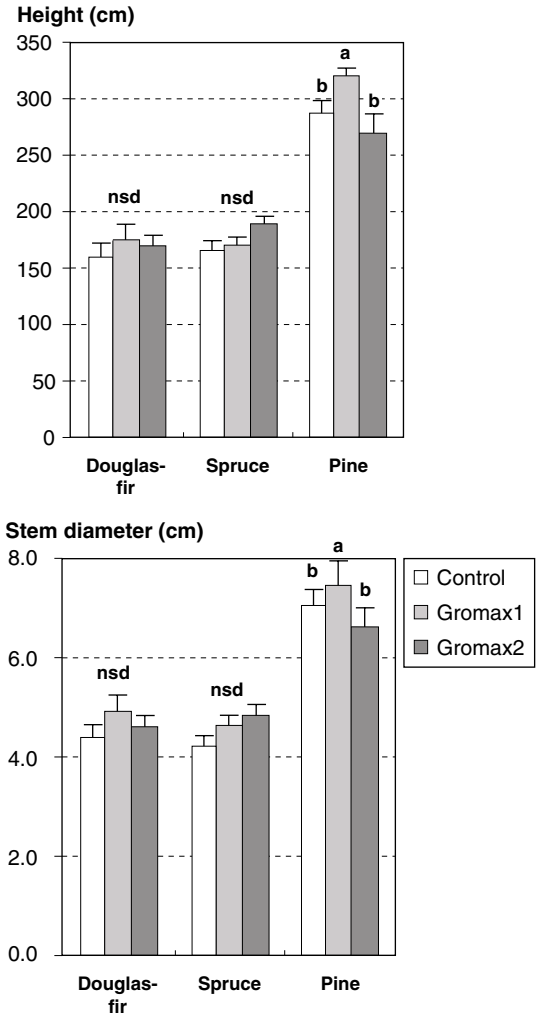

Figure 3. Height and stem diameter of seedlings nine years after fertilization at planting (locations combined). *Error bars are one standard error, and bars with similar letters are not significantly different.*

Discussion

Fertilization of Douglas-fir, Engelmann spruce and lodgepole pine at the time of planting improved seedling performance for two years at Tillis Landing, but most of the significant effects had disappeared by year five. There were no benefits, even during the first two years, to planting seedlings with two Gromax™ teabags instead of one. Fertilization had no effect on survival of any of the species, and neither did it affect the proportion of surviving seedlings that were free growing after nine years. Sutton (1995) reported a similar lack of long-term response to fertilization among white spruce; almost 30 years after treatment, seedlings that had been fertilized were no larger than those in the control, whereas seedlings that had been brushed continued to show a positive response. It has been suggested that the response to fertilization can be improved by concurrent brushing treatments to reduce competition for other site resources and increase the potential for soil warming (Brand and Penner 1989; Ketchum 1997; van den Driessche 1997).

At Tillis Landing, all three species performed better on the mesic than the mesic-subhygric site. By year nine, the percentage of surviving seedlings that were free growing was almost twice as high at Tillis 2 as at Tillis 1. Sutherland and Newsome (1988) found indications of better response to fertilization among spruce on mesic sites than subhygric sites, but at Tillis Landing, even though overall seedling performance was better on the mesic than the subhygric site, there were virtually no differences in the way seedlings responded to fertilization. Douglas-fir at both sites performed poorly in comparison to spruce and pine, probably because of the relatively high elevation (1150 m). Douglas-fir is a recommended species only for lower portions of the ICHmw3.

Competition for light was likely the primary growth-limiting factor on the productive Tillis Landing sites, and fertilization at planting was intended to give seedlings a head start on vegetation. Results at year two suggested that these objectives were being met, but by year five, few significant differences remained to justify the additional cost of approximately $0.13/seedling (Quanstrom 1997). However, fertilization at planting is applied for a variety of purposes, and more lasting improvements to seedling performance may result where site conditions and growth-limiting factors are different. Practitioners are cautioned against drawing conclusions within the first two to three years, though; seedlings should be monitored for at least five years, and should be compared with those in an unfertilized control.

Acknowledgements

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For More Information

A more detailed report including statistical analyses is available.

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