Heating System, Germination Temperature and Post Germination Fertilizer Regime Effects on White Spruce Nursery Growth[1]

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Abstract.--Morphology of white spruce 1-0 seedlings grown with under-bench heating did not differ from those grown with over-bench heating. No differences were observed between 20/11°C (12/12 h, day/night) germinated seedlings and 20/20°C germinated seedlings, although the heating costs of the latter were almost double. Fertilization with N-P-K 20-8-20 produced shorter seedlings with greater root mass than a 20-20-20 plus 10-52-17 fertilizer regime.

INTRODUCTION

The accelerated rate of backlog reforestation programs in north central British Columbia challenge northern latitude nurseries to develop cultural techniques for the production of cost-effective and high performance seedlings. Research specific to northern latitude container seedling production is relatively scarce. Major concerns of northern growers are heating costs during the March to April germination period, crop height control and achieving adequate root mass at harvest.

This report describes trials carried out at Red Rock Research Station (RRRS), located near Prince George, B.C. (Lat. 53°45`N, Long. 122°41`W), to evaluate the effect of:

1. germination temperature setpoints and greenhouse heating systems on the energy costs and morphological development of white spruce, and

2. the effect of two fertilizer regimes on crop morphological development.

METHODS

A white spruce (Picea glauca (Moench) Voss) 1-0 container crop was sown on March 18, 1987 in BCFS/CFS styroblock 313a in a mixture of 2 peat moss : 1 vermiculite, incorporating Osmocote'R' (18-6-12) and 12 mesh lime at 6.5 and 2.0 kg m^{-1}, respectively. Three treatments, combining air temperature setpoints and greenhouse heating systems, were tested for five weeks beginning on 18 March 1987:

1. 20/20°C" with over-bench forced air heating
2. 20/20°C° with unskirted under-bench forced air heating
3. 20/11°C"l with unskirted under-bench forced air heating

Block soil temperature averaged 2° C lower than air temperature setpoints. At the end of the five week germination period, all three temperature regimes were changed to 20/13°C[6], and were gradually lowered over the growing season to harden the plants for harvest on November 2.

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[4] 20/20°C = 24 h at 20°C air temperature setpoint

[5] 20/11°C = 12 h at 20°C air temperature setpoint from 0800 h to 2000 h (day) and 12 h at 11°C air temperature setpoint from 2000 h to 0800 h (night)

[6]20/13°C = 16 h at 20°C air temperature setpoint from 0600 h to 2200 h (day) and 8 h at 13°C air temperature setpoint from 2200 h to 0600 h (night)

Table 1.--Description of experimental treatments by germination air temperature', heating systems and fertilizer regime[3]. A priori contrasts are specified within the 5 treatments.

Contrast	df[4]	20/20°C under-bench 20-20-20	20/20°C over-bench 20-20-20	20/20°C under-bench 20-8-20	20/20°C over-bench 20-8-20	20/11°C under-bench 20-20-20
Germination Temperature Effect	1	1	0	0	0	-1
Heating System Effect at 20/20°C	1	1	-1	0	0	0
Fertilizer Effect[5]	1	1	1	-1	-1	0
Heating Fertilizer Effect[5]	1	1	-1	1	-1	0
Heating by Fertilizer Interaction[5]	1	1	-1	-1	1	0

[1]Germination air temperature: 20/20°C or 20/11°C
[2]Heating system: under-bench or over-bench
[3]Fertilization regime: 20-20-20 or 20-8-20
[4]Degrees of freedom
[5]Contrasts are orthogonal within themselves

Following the germination period, two fertilizer treatments were applied to the 20/20° C temperature treatment germinants:

1. 20-8-20[7] formulation applied for the remainder of the season

2. 20-20-20'(8) formulation applied until July 24, followed by 10-52-17[9] formulation until harvest

Both fertilizer regimes were applied at 120 ppm-N until June 11, at 60 ppm-N June 11-Aug 17, and at 50 ppm-N Aug 17-Nov 2. On August 17, each fertilizer treatment was supplemented with a trace element package") at 0.75 g 1ˉ' of stock solution until harvest on November 2, at which time the seedlings were freezer stored until April 15 when thawing at 5° C was initiated for spring planting on 19 May.

"'Forest Seedling Special", Plant Products Fertilizer Ltd., Bramalea, Ontario Z6T 161
"'Hi-Sol", Green Valley Fertilizers Ltd., Surrey, B.C. V3W 3A8
"'Plant Starter", Green Valley Fertilizers Ltd., Surrey, B.C. V3W 3AB
"' "Plant-Prod Chelated Trace Element Mix", Plant Products Fertilizer Ltd., Bramalea, Ontario Z6T 1G1

Experimental treatments are listed in table I with statistical contrasts of interest specified.

RESULTS

Heater running time during germination and hence direct energy consumption costs, were reduced by almost 50 percent using the 20/11° C germination temperature treatment (Fig. 1).

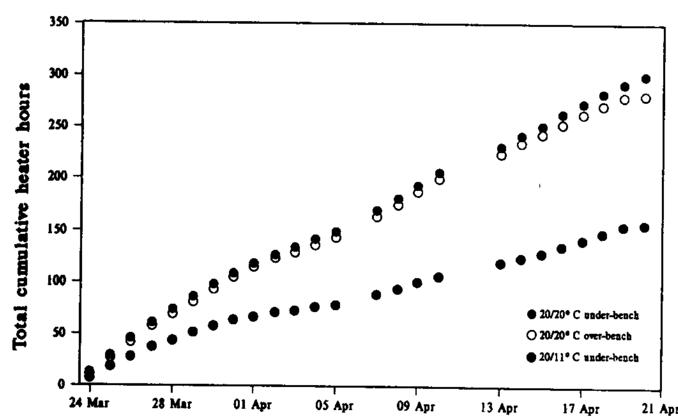

Figure 1.--Greenhouse heater run-time totals during the 1987 germination period.

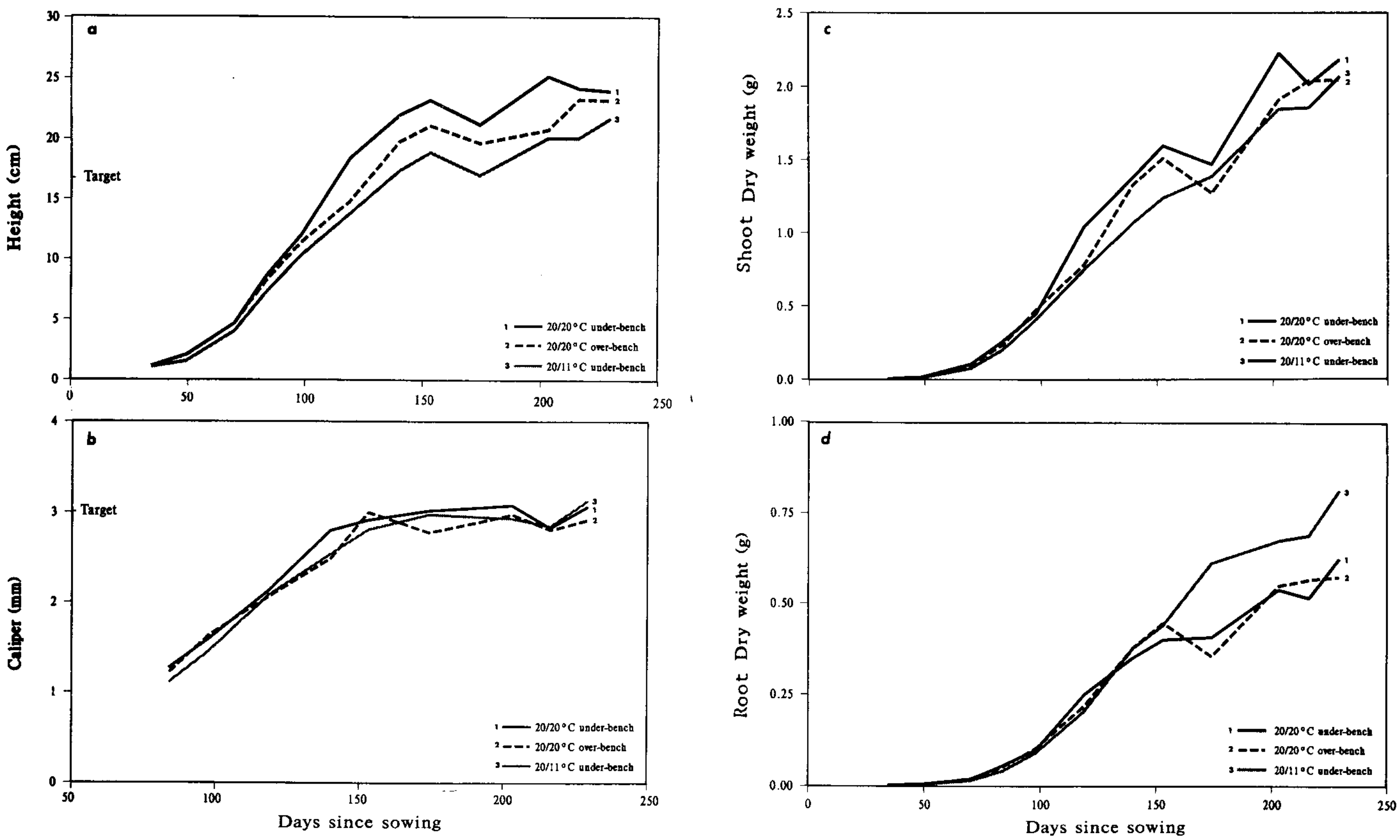

Figure 2.--Cumulative mean height (a), caliper (b), shoot dry weight (c), and root dry weight (d) of white spruce. Values the mean of 20 seedlings.

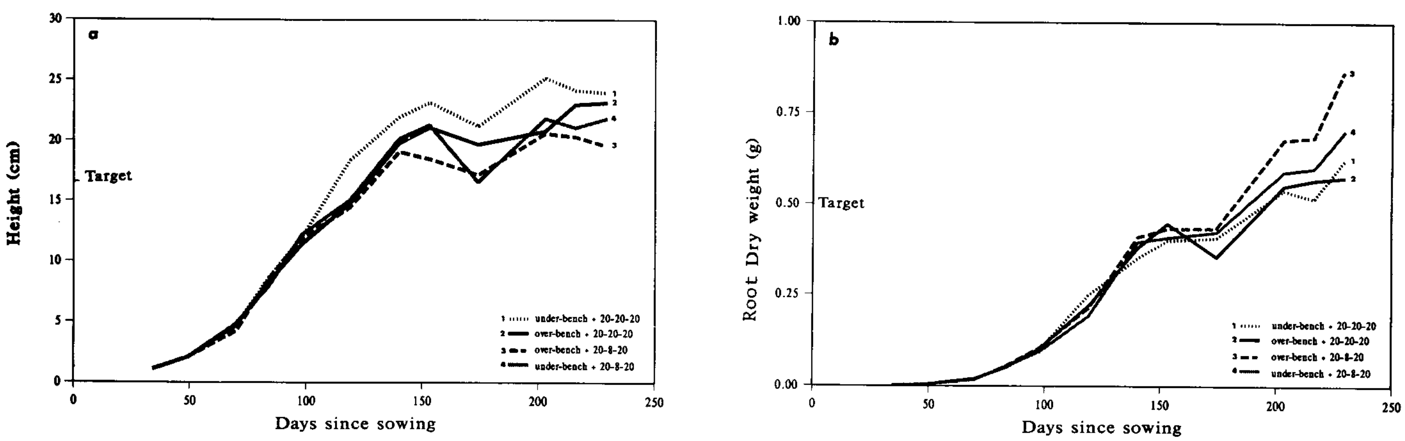

Figure 3.--Cumulative mean height (a), and root dry weight (b) of white spruce. Values the mean of 20 seedlings.

Table 2.--Specified contrast F value and probability of F occurring by chance (bracketed), by morphological variable at end of season.

Contrast	Height	Caliper	Shoot Dry Weight	Root Dry Weight
	(cm)	(cm)	(g)	(g)
Germination Temperature	1.60 (0.21)	0.24 (0.63)	0.20 (0.65)	2.92 (0.09)
Heating System Effect at 20/20°C	0.20 (0.66)	0.84 (0.36)	0.24 (0.63)	0.20 (0.65)
Fertilizer[1]	5.28 (0.02)	1.86 (0.18)	0.48 (0.49)	5.65 (0.02)
Heating[1] System	1.41 (0.24)	0.27 (0.61)	0.27 (0.61)	0.57 (0.45)
F x HST Interaction[2]	0.29 (0.59)	0.63 (0.43)	0.06 (0.80)	1.85 (0.18)

[1]Signifies contrasts are orthogonal within themselves.
[2]Fertilizer x Heating System

There were no practically significant differences in total heater hours between over and under-bench heating systems during the germination period (Fig. 1). Expected cost saving with under-bench heating may not have been realized because benches were not skirted.

There were no significant difference in final seedling height, caliper (root collar diameter), root or shoot dry weight at harvest for either germination temperature regime or heating system (Fig. 2 and Table 2). There was no difference in seedling recovery to height and caliper specifications among treatments.

Seedlings in the 20-8-20 fertilizer regime had significantly *decreased* heights and increased root masses compared to the 20-20-20 regime (Fig. 3 and Table 2). Shoot mass and caliper were not affected by fertilizer treatment (Table 2).

CONCLUSIONS

Heating costs in this study were reduced with the 20/11°C treatment during the germination period without significantly affecting seedling morphology or seedling numbers recovered to height and caliper specifications at harvest.

Significantly shorter seedlings with larger root masses were produced with the 20-B-20 fertilizer regime. Fertilizer regime differences may have been reduced by nutrient available in the Osmocote supplemented growing media.

Results from seedling assessment after one growing season in a farm field environment indicate no nursery treatment differences in survival and performance.

The results from 1987, an excellent growing year, have not been confirmed operationally over a number of growing seasons. Until stock produced via new cultural regimes is field tested, it has no place in operational practices. The goal of forest regeneration is not to produce stock that "looks good" in the nursery but to produce stock that performs well in the field.

ACKNOWLEDGEMENTS

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