Manual Root Pruning of PSB 313 Interior Spruce
on Mounded and Unmounded Spots in the
Prince George Region

Interim Report

By

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April 1991
TITLE: Manual Root Pruning of PSB 313 Interior Spruce on Mounded and Unmounded Spots - Prince George Region

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INTRODUCTION


Carlson and Preisig (1981) reported that adjacent application of osmocote to trees stimulated root growth in all zones surrounding the seedling, not just the zone in which fertilizer was applied.

The purpose of mounding is to develop raised microsites which results in increased soil temperature, good nutrient access, and a reduction in excess water. Site preparation trials undertaken by McMinn and Herring have indicated increased growth of spruce on mounded sites.

This study compares survival, height, and root collar diameter of PSB 313 interior spruce plugs manually pruned to three different plug lengths with that of fertilized plugs and a control treatment planted on mounded and unprepared planting spots.

This report summarizes the results to date after the third growing season.
METHODOLOGY

The stock planted was PSB 313 interior spruce. The treatments used were:

CO - Control treatment with no manual pruning of roots
MP1 - PSB 313 plugs manually pruned 1 cm from the bottom of the root tip
MP3 - PSB 313 plugs manually pruned 3 cm from the bottom of the root tip
MP5 - PSB 313 plugs manually pruned 5 cm from the bottom of the root tip
F1 - PSB 313 plugs fertilized at planting using Osmocote 18-6-12 (N, P, K) with a nine month release period (25°C) with no root pruning.

These 5 treatments were planted on both site prepared (mounded) and unprepared (unmounded) planting spots for a total of 10 treatments.

Two locations were established in the Prince George region in the spring of 1987. One site was located at Kluskus Road (Vanderhoof District) in the SBS dk zone. The other site was located at Iron Creek (Fort St. John District) in the BWBS mw1 zone. Both sites were subhygic and were site prepared by mounding in 1986. The Sinkilla was used to mound the Kluskus and Iron Creek sites.

Each of the 10 treatments consisted of 4 replications of 35 trees spaced 2.0 m apart. A total of 40 rows spaced 3.0 m apart were established at each of the two sites for a total of 2800 trees.

Survival, height and root collar diameter data were recorded at establishment and in the Fall of 1987, 1988 and 1989. Further assessments are scheduled for the fall of 1991 and 1996. An analysis of variance was conducted on these variables to determine any significant differences between treatments.
SITE AND STOCK DESCRIPTIONS
FOR MANUAL ROOT PRUNING AND MOUNDING
TRIAL SX86127Q

SITE DESCRIPTION

Former Stand: S (PL)
Biogeoclimatic Zone/Subzone: BWBS mw1
Ecosystem Association: 06
Moisture Regime: subhygric
Nutrient Regime: mesotrophic
Vegetative Competition: medium-high
Soil Type: Brunisol
Soil Texture: silty clay loam
Humus Form: moder
Aspect: flat
Slope: 0%
Elevation: 850 m
Year of Logging: 1966
Year of Site Prep: Burned 1974

IRON CREEK
Ft. St. John

KLUSKUS
Vanderhoof

SX
SBS dk
08
subhygric
mesotrophic
medium-high
Orthic Podzol
silt loam
mor
west
5%
881 m
1977

Mounded 1986
Sinkilla

STOCK DESCRIPTION

Species Planted: Sx
Stock Type: PSB 313A
Seedlot: 2665
Nursery: IFS
Lift Date: 86/11/06
Planting Date: 87/05/05

Sx
PSB 313A
2674
IFS
86/11/21
87/06/05

WEATHER CONDITIONS

At time of planting: overcast with some rain
Precipitation after planting: heavy rains prior to and after planting
sunny
no appreciable rain for 2 months after planting
RESULTS

For the variables:

1. survival,
2. height increment,
3. root collar diameter (RCD) increment,
4. stem volume, and
5. stem to RCD (SR) ratio,

graphs are presented of the results of the 10 treatments. These graphs are accompanied by summaries of the statistical analyses of the treatments by location.

The mounds produced at the Kluskus site using the Sinkilla were generally poorer in quality than those at the Iron Creek site using the Sinkilla. The Kluskus mounds had more organic material and less mineral soil capping than the mounds produced at Iron Creek.

Over 54% of the mounds at Kluskus had less than 13 cm of mineral soil capping over inverted organic soil (I. Hedin 1988). Often unacceptable mounds were prepared because slash, stumps, brush, and roots caused poor ground contact by the site preparation equipment. Many of the mounds had a large percentage of organics and were loosely packed. This resulted in the mounds having a poor ability to store water or to provide capillary water flow through the soil to the seedlings.

The Kluskus site received less precipitation throughout the May - September 1987 growing season than the Iron Creek site.

The combination of poorer mounds and less precipitation at Kluskus resulted in seedlings having generally poorer survival and growth than at the Iron Creek site.
Survival

**Iron Creek By Treatment:** A Chi-square test indicates that there were significant differences (p<0.05) in survival of the 10 treatments after 3 growing seasons. All seedlings in mounded treatments had higher survival rates than in corresponding unmounded treatments. Survival in mounded treatments ranged from 94-100% while in unmounded treatments survival ranged from 85-96%. Manually pruned seedlings (MP) had as good survival as unpruned (CO) seedlings. However, frost and overwinter damage occurred on 23-34% of the mounded seedlings. Only 11-20% of the unmounded seedlings received frost and overwinter damage. Frost and overwinter damage did not vary significantly by treatment on the mounds. The raised microsites created by mounding, exposed seedlings to increased susceptibility to frost and overwinter damage. Lack of snow cover during the winter of 1987 and 1988 were contributing factors to overwinter damage.

**Kluskus By Treatment:** A Chi-square test indicates that there were significant differences (p<0.05) in survival of the 10 treatments after 3 growing seasons. All seedlings in mounded treatments had lower survival rates than in corresponding unmounded treatments. Survival in mounded treatments ranged from 64-75% while in unmounded treatments survival ranged from 94-100%. This was probably a result of the poor quality of the mounds and the lack of precipitation in the first growing season.

**Between Locations:** A Chi-square test for treatments at each location, indicates that there were differences in survival of the 10 treatments after 3 growing seasons. The Iron Creek site had higher survival rates than the Kluskus site. The results from the 2 locations also show opposing or slightly differing survival rates for the various treatments. The poor quality of the mounds prepared by the Sinkilla, and the lack of precipitation in the first growing season at the Kluskus site was the probable cause of the unexpectedly poor survival on the mounded treatments.

Graph 1 shows the percent survival by location and site preparation for the 10 treatments.
Graph 1A. Survival
Summary of treatments at Iron Creek
Third year results

Graph 1B. Survival
Summary of treatments at Kluskus
Third year results
**Height Increment**

**Iron Creek By Treatment:** An analysis of variance indicates that there were significant differences (p<0.05) in height increment between the 10 treatments after 3 growing seasons. Control (CO) seedlings on Mounds had significantly greater height increment than those on unprepared ground. Total height increment over three years ranged from 11.6 - 19.4 cm with the manually pruned 5 cm (MP5) and fertilized (F1) seedlings on mounded and unmounded spots having some of the largest increments. The manually pruned 3 cm (MP3) seedlings did poorer than the manually pruned 1 cm (MP1) seedlings. A general trend at this site was that treatments on mounds had greater 3 year height increments than did the treatments on unprepared ground.

**Kluskus By Treatment:** An analysis of variance indicates that there were significant differences (p<0.05) in height increment between the 10 treatments after 3 growing seasons. The seedlings manually pruned 3 cm and planted on unprepared ground had significantly greater height increments than seedlings pruned 3 cm and planted on mounds. Total height increment over three years ranged from 6.1 - 13.2 cm. In general, all unmounded treatments had greater height increments than mounded treatments. This was probably a result of the poor quality of the mounds at this site as discussed previously.

**Between Locations:** Analysis of variance indicates there was a significant difference (p<0.05) between the sites in the overall 3 year height increment. Height increments at the Iron Creek site were much higher than at the Kluskus site. Mound quality and lack of precipitation probably contributed to the poorer performance at the Kluskus site.

Graph 2 shows the total three year height increment by location and site preparation for the 10 treatments.
Graph 2A. Height Increment
Summary of treatments at Iron Creek
Third year results

Graph 2B. Height Increment
Summary of treatments at Kluskus
Third year results
Root Collar Diameter (RCD) Increment

Iron Creek By Treatment: An analysis of variance indicates that there were significant differences (p<0.05) in RCD increment between the 10 treatments after 3 growing seasons. The Control (CO) seedlings, the seedlings manually pruned 3 cm (MP3) and 5 cm (MP5) and planted on mounds had significantly greater 3 year RCD increments than those planted on unprepared ground. RCD increments ranged from 2.7 - 4.4 mm. In general, all mounded treatments had greater RCD increments than unmounded treatments.

Kluskus By Treatment: An analysis of variance indicates that there were significant differences (p<0.05) in RCD increment between the 10 treatments after 3 growing seasons; however, no one group of treatments performed significantly better than the others. Total RCD increment over three years ranged from 2.2 - 3.3 mm. Fertilized (F1) seedlings on mounds had the greatest RCD increment, followed by fertilized (F1) seedlings on unmounded sites. Seedlings in all other mounded treatments performed as well as in the comparable unmounded treatments, even though the quality of the mounds at this site was poor.

Between Locations: Analysis of variance indicates there was a significant difference (p<0.05) between the sites in the overall 3 year RCD increment. Total RCD increment over three years at the Iron Creek site were much higher than at the Kluskus site. This was probably a result of the poor quality of the mounds, the lack of precipitation, and the frost damage at the Kluskus site.

Graph 3 shows the total three year RCD increment by location and site preparation for the 10 treatments.
Graph 3A. Root Collar Diameter Increment Summary of treatments at Iron Creek Third year results

Graph 3B. Root Collar Diameter Increment Summary of treatments at Kluskus Third year results
Volume

Seedling stem volume was calculated by the following formula: \( (1/3 \pi ((RCD/2)^2 \times \text{Height}) \). The calculated volume in cubic centimetres is a combined measure of height and root collar diameter and gives an indication of total seedling biomass.

**Iron Creek By Treatment:** An analysis of variance indicates that there were significant differences \((p<0.05)\) in the volume between the 10 treatments after 3 growing seasons. The Control (CO) seedlings, the seedlings manually pruned 3 cm (MP3) and 5 cm (MP5) and planted on mounds had significantly greater volumes after 3 years than those planted on unprepared ground. Third year volumes ranged from 2.1 - 4.8 cc. In general, all mounded treatments had larger volumes than unmounded treatments.

**Kluskus By Treatment:** An analysis of variance indicates that there were significant differences \((p<0.05)\) in the volume between the 10 treatments after 3 growing seasons. The Control (CO) seedlings planted on mounds had significantly greater volumes after 3 years than those planted on unprepared ground. Third year volumes ranged from 1.9 - 3.3 cc. Fertilized (F1) seedlings on mounds had the largest volume followed by fertilized (F1) seedlings on unmounded sites. Seedlings in all other mounded treatments performed as well as in the comparable unmounded treatments, even though the quality of the mounds at this site was poor.

**Between Locations:** Analysis of variance indicates there was a significant difference \((p<0.05)\) between the sites in the calculated volume. Volumes at the Iron Creek site were much higher than at the Kluskus site. Poor mound quality, and lack of precipitation reduced volume growth at the Kluskus site.

Graph 4 shows the calculated volume by location and site preparation for the 10 treatments.
Graph 4A. Stem Volume
Summary of treatments at Iron Creek
Third year results

Graph 4B. Stem Volume
Summary of treatments at Kluskus
Third year results
Seedling stem to RCD ratio was calculated by the formula Height/RCD. The calculated stem to RCD ratio (referred to as the SR ratio) is a combined measure of height and root collar diameter and gives an indication of seedling sturdiness. Seedlings with a smaller ratio may be more sturdy and better able to withstand vegetation or snow press.

**Iron Creek By Treatment:** An analysis of variance indicates that there were significant differences (p<0.05) in the SR ratio between the 10 treatments after 3 growing seasons. Fertilized seedlings on unprepared ground had a significantly greater SR ratio than all other treatments. This would indicate a tall tree with relationally smaller RCD - perhaps a less sturdy tree than the other treatments. Seedlings manually pruned 3 cm and planted on unprepared ground had significantly larger SR ratios than seedlings planted on mounds. Third year SR ratios ranged from 44.9 - 63.3. All treatments on the mounds had slightly lower SR ratios than treatments on unprepared ground. This may indicate that seedlings on mounds are more balanced trees, possibly better able to withstand snow press.

**Kluskus By Treatment:** An analysis of variance indicates that there were significant differences (p<0.05) in the volume between the 10 treatments after 3 growing seasons. Fertilized seedlings and seedlings manually pruned 1 and 3 cm on unprepared ground had a significantly greater SR ratios than the same seedlings planted on mounds on mounds. Third year SR ratios ranged from 51.8 - 60.6. In general, all mounded treatments had smaller SR ratios than unmounded treatments.

**Between Locations:** Analysis of variance indicates there was a significant difference (p<0.05) between the sites in the calculated SR ratio. SR ratios at the Iron Creek site were much smaller than at the Kluskus site.

Graph 5 shows the calculated SR ratio by location and site preparation for the 10 treatments.
Graph 5A. Stem to RCD Ratio
Summary of treatments at Iron Creek
Third year results

Graph 5B. Stem to RCD Ratio
Summary of treatments at Kluskus
Third year results
Root Development: Iron Creek

Root Growth Capacity at Time of Planting

The pruned seedling had a much lower index of root growth than the other seedlings. Seedlings manually pruned 1, 3, and 5 cm had RGC's of 0.43 - 1.06. Unpruned seedlings had RGC's of 1.63. The lower RGC's in the pruned seedlings did not appear to adversely affect survival.

Development of Roots

At Iron Creek, the trees which were planted on mounds had significantly greater lateral root growth or egress than those planted on unprepared spots. In general, the trees planted on unprepared ground often had limited or no new root egress since planting. The trees planted on mounds had generally very good root egress. Mounds which were primarily compacted clay or mineral soil, with no organic or humus mixing (or little soil aeration), had less root egress than mounds with some organic mixing. Seedlings which had been manually pruned 1, 3, and 5 cm exhibited root egress equal to or greater than the other treatments. Manual pruning did not appear to restrict root growth in the first year. Trees which had been fertilized on mounds exhibited root egress equal to the other treatments. However, fertilized trees on unprepared ground appeared to have more root egress than unfertilized seedlings. These are only preliminary visual observations confirmed with photographs and videotape recording. These first year observations would indicate that raised microsites such as mounding promote much better root egress than non-mounded sites. Soil temperature and moisture conditions are significantly enhanced on mounded subhygic sites resulting in increased seedling root growth.
Root and Shoot Dry Weights

After one growing season, the dry weights of the shoots and roots were not significantly different between treatments. However, seedlings planted on the unprepared spots had in general lower shoot and root weights than seedlings planted on mounded spots. Seedlings on mounded spots had average shoot weights from 3.54 - 4.58 grams while seedlings on unprepared spots had average root weights of 2.93 - 3.34 grams. Seedlings on mounded spots had average root weights from 0.93 - 1.34 grams while seedlings on unprepared spots had average root weights of 0.51 - 1.02 grams. The mounded seedlings generally had better increments in shoot and root weights than unmounded seedlings.

Graph 6A shows the change in shoot and root weight for the 10 treatments at Iron Creek.
Graph 6A. Change in Root & Shoot Weight
Summary of treatments at Iron Creek
First year root & shoot weight increment

Treatments

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<td>CO - U</td>
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<td>F1 - M</td>
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<td>F1 - U</td>
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M - Mounded
U - Unmounded

- CO - Control with no manual pruning
- MP1 - PSB 313 plugs manually pruned 1cm
- MP3 - PSB 313 plugs manually pruned 3cm
- MP5 - PSB 313 plugs manually pruned 5cm
- F1 - PSB 313 plugs fertilized with Osmocote
Root Development:

Kluskus

Root Growth Capacity at Time of Planting
The pruned seedlings had a lower index of root growth than the other seedlings. Pruned seedlings had RGC’s 1.13 - 1.25 while unpruned seedlings had RGC’s of 1.94. The lower RGC’s in the pruned seedlings did not appear to adversely affect survival.

Development of Roots
The trees planted on unprepared ground often had limited or no new root egress since planting. The trees planted on mounds had generally good root egress. Seedlings which had been pruned 1, 3, and 5 cm exhibited root egress equal to or greater than the other treatments. Pruning did not appear to restrict root growth in the first year. Trees which had been fertilized on mounds exhibited root egress equal to the other treatments. However, fertilized trees on unprepared ground appear to have more root egress than unfertilized seedlings. First year observations would indicate that raised microsites promote better root egress than unprepared sites. Root pruned seedlings did not exhibit more root egress than control seedlings on unprepared sites.

Shoot and Root Dry Weights
The root and shoot weight trends observed at Iron Creek were reversed at Kluskus. Seedlings planted on the unprepared spots had in general higher shoot and root weights than seedlings planted on mounded spots. Seedlings on mounded spots had average shoot weights from 3.06 - 3.74 grams while seedlings on unprepared spots had average shoot weights of 3.99 - 5.44 grams. Seedlings on mounded spots had average root weights from 0.63 - 1.00 grams while seedlings on unprepared spots had average root weights of 1.07 - 1.78 grams. Manual root pruning or fertilizing did not appear to significantly affect root or shoot weight. Figure 6 and 7 show the first year root and shoot weight change in the treatments. The drier site and poorer mound quality at Kluskus resulted in mounded seedlings having generally poorer weights.

Graph 6B shows the change in shoot and root weight for the 10 treatments at Kluskus.
Graph 6B. Change in Root & Shoot Weight
Summary of treatments at Kluskus
First year root & shoot weight increment

Treatments

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<td>F1 - M</td>
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M - Mounded
U - Unmounded

- CO - Control with no manual pruning
- MP1 - PSB 313 plugs manually pruned 1cm
- MP3 - PSB 313 plugs manually pruned 3cm
- MP5 - PSB 313 plugs manually pruned 5cm
- F1 - PSB 313 plugs fertilized with Osmocote
CONCLUSION

This study compared the performance of PSB 313 interior spruce plugs manually pruned to three different plug lengths with that of fertilized plugs and a control treatment planted on prepared and unprepared planting spots.

Two locations were established in the Prince George Region in the Spring of 1987. One site was located at Kluskus Road (Vanderhoof District) and the other site at Iron Creek (Fort St. John District). The Sinkilla was used to mound the Kluskus site and the Ministry mounder was used to mound the Iron Creek site.

The Kluskus site had poorer quality mounds, less precipitation, and more frost damage than the Iron Creek site.

Comparisons were made between locations and treatments of survival, height increment, root collar diameter (RCD) increment, volume, and stem to RCD (SR) ratio.

Iron Creek results by treatment for each variable analysed were:

- Survival - mounded > unmounded.
- Height increment generally mounded > unmounded.
- RCD increment - mounded > unmounded.
- Volume - mounded > unmounded.
- SR ratio - mounded seedlings have a lower ratio (possibly more sturdy) than unmounded seedlings.

Kluskus results by treatment for each variable analysed were:

- Survival - mounded < unmounded.
- Height increment - mounded < unmounded.
- RCD increment - no pattern evident.
- Volume - no pattern evident.
- SR ratio - mounded seedlings have a lower ratio (possibly more sturdy than unmounded seedlings.)
By Treatment: In general, mounded treatments performed better or as well as unmounded treatments at the Iron Creek site. The opposite was exhibited for mounded treatments at the Kluskus site except for the SR ratio. These differing results may be a result of the poor quality of the mounds and less precipitation at the Kluskus site.

By Location: The Iron Creek site had much higher survival, height increment, RCD increment, and volume and lower SR ratio than the Kluskus site for all treatments. Again, these differing results may be a result of the poor quality of the mounds and less precipitation at the Kluskus site. Unfortunately, it is not possible to determine whether better quality mounds would have outweighed environmental factors at the Kluskus site and produced results similar to Iron Creek.

RECOMMENDATION

Detailed survival, height, and root collar diameter measurements be carried out in the Fall of 1991. In addition, careful excavation and detailed measurements of seedlings root development should be carried out to determine treatment differences.
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<td>Plot Layout</td>
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## APPENDIX 4

### PLOT LAYOUT

**SX86127 Q**

**MANUAL ROOT PRUNING OF INTERIOR SPRUCE STOCK**

**PLANTED ON PREPARED AND UNPREPARED SPOTS**

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*Trees for survival measure*  *Trees for excavation*

**TREES 11-20 USED FOR HEIGHT AND ROOT COLLAR MEASURE**

**SITE PREPARATION**  
M - Mounded  &  NM - Non Mounded