Sx 81104 Q

PLUG TRANSPLANT TRIAL

Final Report
1986

C. Clarke
R. Winter
REPORT SX 81104 0

INTERIM □

FINAL X

DATE 86-04-25

TITLE PLUG TRANSPLANT TRIAL

Report prepared by: CLARK (Signature)

R. WINTER & C. CLARKE (Typed)

Report & distribution approved by: BROWN (Signature) (for Regions - Silviculture Officer)

R. BROWN (Typed)

(a) Wide Distribution X

(b) Limited □

(i) Internal - Branch only □

(ii) External - Designated □

(iii) Ministry only □

COPIES TO:

SILVICULTURE OFFICERS - ALL REGIONS
RESEARCH OFFICERS - ALL REGIONS
DISTRICT MANAGERS - ALL INTERIOR DISTRICTS
NURSERY MANAGER - SILVICULTURE BRANCH
LIBRARY - SILVICULTURE BRANCH
C.O.F.I.
C.L.M.A.
I.L.M.A.
N.I.L.A.

All Nurseries
Nursery Administration Officers

Approved:

Manager - (Signature) (for Regions - Forestry Manager)

R.C. JONES (Typed)
Abstract

A trial to compare performance of Interior Spruce (Picea glauca Moench) grown as transplanted plugs with that of PSB 313, 2+0 bare-root, and 2+1 bare-root. This trial was established in the Wansa Lake area of the Prince George Region Sub Boreal Spruce zone on a brush prone site.

After five years the PSB 313 averaged 95 cm, 2+1 bare-root 91 cm, 1P+1 transplants 86 cm, and the 2+0 bare-root 68 cm. There was no statistical significant difference in height and root collar diameter for three stock types. But the 2+0 BR had a statistically lower height and root collar diameter. Results after five years indicated 95% survival for PSB 313, 95% for 2+1 bare-root, 85% for 1P+1 and 60% for 2+0 bare-root.

Considering the cost of producing plug transplants (about 29¢/tree) and their lower total height and lower survival percent compared to the PSB 313 (about 16.5¢/tree to produce), it is an expensive stock type to plant with few favourable results.

This trial confirms earlier work by van den Driessche and McMinn which illustrated that there are no performance increases to be gained by using PBR transplants over PSB 313 container stock.
Introduction

The success rate of Interior Spruce plantations in the Prince George Region is thought not to exceed 50%\(^1\). Failure in most cases is attributed to the inability of the planted trees to compete with surrounding vegetation. There are a number of means by which plantation failure due to this cause can be reduced. One is to suppress competing vegetation either by pre-planting site treatments (e.g., burning, or mechanical preparation) or by post-planting weed control measures (e.g., mechanical weeding, or herbicide application).

Another way of contending with the effect of competing vegetation in forest plantations is to increase the size and vigor of the planting stock used.

Proper stock selection appears to be one possible solution to the problems of brushy sites. There is a need for "balanced" stock with wood stems, strong terminal buds, good root collar diameter and good compact root systems. Plug transplant stock has been touted to have superior leader growth in early stages of growth.

This project was established in the spring of 1981. Spruce plug transplant stock was planted next to regular plug stock, transplant bareroot stock and regular two year old bareroot stock. Results of growth measurements and survival data for 1982 and 1985 were statistically analyzed and are presented and discussed.

METHOD

1. Location

C.P 17, Block D, A04463 (Carrier Lumber), Wansa Lake, Prince George TSA (Willow River PSYU), F.D. 2, Prince George Region (see maps, Appendices 1 & 2).

2. Object

To compare the performance of Interior Spruce grown as transplanted plugs with that of PSB 313, 2+0 bareroot, and 2+1 bareroot, when planted on a brush prone site.

3. Treatment & Code

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB 313</td>
<td>PSB</td>
</tr>
<tr>
<td>PBR 1+1 (PSB 211+1)</td>
<td>PBR</td>
</tr>
<tr>
<td>2+0 bareroot</td>
<td>2+0</td>
</tr>
<tr>
<td>2+1 bareroot</td>
<td>2+1</td>
</tr>
</tbody>
</table>

4. Plot Layout

4 replications (plots) x 4 stock types x 2 lines per plot x 50 trees per line = 1600 trees in all.

Spacing within rows = 1.5 m; between rows = 3.0 m, between plots 6 m.

5. Planting Dates & Weather

Date

81-05-22

Conditions

Rained - previous night: Limited moisture in top 5 cm, uniformly damp in root zone. Sunny with cloudy periods. Winus 5-15 km/h.

Temperature 12-19°C. Following planting: Cool with light showers.

6. Assessed

82-11-10

7. Seedlot #1856

Si 93G16/B2/850 m/Wansa Lake
8. **Stock Handling & Condition**

Picked up PSB 313 from Koksilah May 18/81.
Picked up remainder from Surrey May 19/81.
Bareroot stock was frozen in storage. Boxes stored in standing timber with tops partly open May 20-21. All planted May 22 by a 3-person hired crew; planting quality was very good.

Condition of stock was generally satisfactory except for some dry tops in 2+1 and some needle cast in the lower foliage of the 2+0.

9. **Site Factors**

(a) Former stand: Spp
(b) Biogeoclimatic subzone
(c) Moisture
(d) Soil Nutrients
(e) Seedzone
(f) Elevation, m
(g) History
(h) Slope % & Aspect
(i) Topography
(j) Soil Texture
(k) Organic layer (LFH)
(l) Planting in, %
(m) Vegetative competition
(n) Slash: % cover & ht., cm.

S + B Pl F
SBSj1
Med.
Med.
6010
910
L.70, B. 80
5-15, East
Lower slope
Clay & gravel
5 cm but mostly absent
Mineral soil 70, duff, 25, mixed 5
Light (in Spring '81)
10-50
RESULTS

The survival, height and caliper of the four stock types was measured at establishment, after two growing years and after five growing years. Table 1 and 2 summarize the measurements over five years.

TABLE 1

HEIGHT OF STOCK (IN CM)

<table>
<thead>
<tr>
<th>STOCK TYPE</th>
<th>AT Planting</th>
<th>95% confidence interval</th>
<th>AFTER 2 YEARS</th>
<th>95% CONFIDENCE interval</th>
<th>AFTER 5 YEARS</th>
<th>95% CONFIDENCE interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB 313</td>
<td>24</td>
<td>+ 1.5</td>
<td>42.0</td>
<td>+ 1.7</td>
<td>95.0</td>
<td>+ 5.8</td>
</tr>
<tr>
<td>2 + 0 BR</td>
<td>21</td>
<td>+ 3.1</td>
<td>25.0</td>
<td>+ 2.2</td>
<td>68.0</td>
<td>+ 6.1</td>
</tr>
<tr>
<td>2 + 1 BR</td>
<td>24</td>
<td>+ 1.6</td>
<td>34.0</td>
<td>+ 2.1</td>
<td>91.0</td>
<td>+ 6.0</td>
</tr>
<tr>
<td>1P + 1</td>
<td>29</td>
<td>+ 3.3</td>
<td>37.0</td>
<td>+ 2.1</td>
<td>86.0</td>
<td>+ 8.1</td>
</tr>
</tbody>
</table>

In the fall of 1985 the final assessments of the trial were performed. Height, diameter and survival data was collected. PSB313 was the tallest on average, followed by 2+1 BR, 1p +1 and then 2+0 BR.

TABLE 2

<table>
<thead>
<tr>
<th>STOCK TYPE</th>
<th>ROOT COLLAR DIAMETER (mm) (at 5 yrs)</th>
<th>SURVIVAL OF STOCK AFTER 2 YEARS</th>
<th>SURVIVAL OF STOCK AFTER 5 YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB 313</td>
<td>17.7</td>
<td>97</td>
<td>95</td>
</tr>
<tr>
<td>2+0 BR</td>
<td>12.4</td>
<td>62</td>
<td>60</td>
</tr>
<tr>
<td>2+1 BR</td>
<td>15.8</td>
<td>97</td>
<td>95</td>
</tr>
<tr>
<td>1P+1</td>
<td>16.7</td>
<td>88</td>
<td>85</td>
</tr>
</tbody>
</table>

The PSB 313 had the largest average root collar diameter at 17.7 mm. The transplant plug stock had an average of 16.9 mm followed by the 2+1 BR with 15.8 mm and the 2+0 BR with only 12.4 mm root collar diameter. Average survival was 95% for the PSB 313, 95% for 2+1 BR, 85% for the 1p+1 and 60% for the 2+0 Bareroot.

Graph 1 portrays the average height of the various stock types at planting, after two years and after five years.

Graph 2 shows the relative differences in survival after two years and after five years.
GRAPH 1
SX81104Q PLUG TRANSPLANT TRIAL
LOCATION -- WANSA LAKE

TOTAL AVERAGE HEIGHT (CM)

PSB 313  2 + 0 BR  2 + 1 BR  1P + 1

MT AT PLANTING  MT AT 2 YRS  MT AT 5 YRS

STOCK TYPE
GRAPH 2
SX81104Q PLUG TRANSPLANT TRIAL
LOCATION -- WANSA LAKE

AVERAGE SURVIVAL

SURVIVAL AT 2 YRS

STOCK TYPE

SURVIVAL AT 5 YRS
Graph 3 shows boxplots of the height data collected (after five years) for the four stock types. The boxplots show that 2+0 BR had a small variation around the mean height while the lp+1 stock had the largest variation around the mean height (CV = 30.5). PSB 313 had the tallest average height, and had the lowest coefficient of variation (19.5).

Graph 4 shows boxplots of root collar diameter data collected (after five years) for the four stock types. The boxplots again show that 2+0 BR had the smallest average RCD and variation around the mean. The lp+1 stock had the largest variation around the mean root collar diameter (CV = 28.1).

An analysis of variation of the height and root collar diameter of PSB 313, 2+1 bareroot and lp+1 stock, reveals that there are no significant differences (at the 0.05 level). See appendix 5 for the detailed ANOVA and Duncan's Multiple Range test.

What is important is the data which shows that the 2+0 BR is significantly smaller than the other stock types in height and diameter. The 2+0 BR had also a significantly poorer survival rate than the other stock types.

CONCLUSION:

After five years on a SBSjl (Willow River Wet Cool Central Sub-Boreal Spruce zone) brush prone site, PSB 313 stock had the largest average height (95 cm) followed by 2+1 bareroot (91 cm), lp+1 transplants (86 cm) and 2+0 bareroot (68 cm). 2+0 BR had significantly lower height and caliper measurements than the other stock types. The 2+0 bareroot stock also had the lowest survival after five years.

On this site plug transplants did not provide any advantages or height growth differences over 2+1 Bareroot or PSB 311 stock.

Considering the cost of producing plug stock and its good performance, PSB 313 was the most successful stock type on this site. This trial data would support the Silviculture Branch direction of growing more container stock and less bareroot stock.

One note of caution in the use of the data is that there may be some nursery effect compounding the results of this trial. The PSB 313 was produced at Koksilah Nursery, while the other stock was produced at Surrey Nursery.
## Appendices

<table>
<thead>
<tr>
<th>Appendix Number</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Key map</td>
</tr>
<tr>
<td>2</td>
<td>Plot location</td>
</tr>
<tr>
<td>3</td>
<td>Illustrations of stock types</td>
</tr>
<tr>
<td>4</td>
<td>Illustrations of the trial site at time of planting and after one growing season.</td>
</tr>
<tr>
<td>5</td>
<td>Detailed Statistical Analysis</td>
</tr>
</tbody>
</table>
SITE AT TIME OF PLANTING

SITE AFTER 1 GROWING SEASON
SX81104Q STOCK TRIAL
WANSA LAKE
APPENDIX 5
"SX81104Q -- STOCK TRIAL -- WANSA LAKE"
"LISTING OF MEANS FOR VARIABLE RCD"
16:36 WEDNESDAY, MARCH 5, 1986

<table>
<thead>
<tr>
<th>STOCK</th>
<th>NUM</th>
<th>RCD</th>
<th>STD</th>
<th>STDERR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB 313</td>
<td>40</td>
<td>17.6825</td>
<td>3.78539</td>
<td>0.598523</td>
</tr>
<tr>
<td>2+0 BR</td>
<td>30</td>
<td>12.3667</td>
<td>3.29747</td>
<td>0.602034</td>
</tr>
<tr>
<td>2+1 BR</td>
<td>40</td>
<td>15.785</td>
<td>3.46518</td>
<td>0.547893</td>
</tr>
<tr>
<td>1P + 1</td>
<td>40</td>
<td>16.6875</td>
<td>4.69234</td>
<td>0.741924</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STOCK</th>
<th>VAR</th>
<th>CV</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB 313</td>
<td>14.3292</td>
<td>21.4075</td>
<td>8.8</td>
<td>24</td>
</tr>
<tr>
<td>2+0 BR</td>
<td>10.8733</td>
<td>26.6642</td>
<td>6.8</td>
<td>22.1</td>
</tr>
<tr>
<td>2+1 BR</td>
<td>12.0075</td>
<td>21.9523</td>
<td>5.7</td>
<td>21.6</td>
</tr>
<tr>
<td>1P + 1</td>
<td>22.018</td>
<td>28.1189</td>
<td>8.7</td>
<td>25</td>
</tr>
</tbody>
</table>

"SX81104Q -- STOCK TRIAL -- WANSA LAKE"
"ANALYSIS FOR RCD"
16:36 WEDNESDAY, MARCH 5, 1986

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: RCD

NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE, NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=146 MSE=15.0764

WARNING: CELL SIZES ARE NOT EQUAL.
HARMONIC MEAN OF CELL SIZES=36.9231

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

<table>
<thead>
<tr>
<th>DUNCAN GROUPING</th>
<th>MEAN</th>
<th>N</th>
<th>STOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>17.682</td>
<td>40</td>
<td>PSB 313</td>
</tr>
<tr>
<td>B</td>
<td>16.687</td>
<td>40</td>
<td>1P + 1</td>
</tr>
<tr>
<td>B</td>
<td>15.785</td>
<td>40</td>
<td>2+1 BR</td>
</tr>
<tr>
<td>C</td>
<td>12.367</td>
<td>30</td>
<td>2+0 BR</td>
</tr>
</tbody>
</table>
STOCK  | NUM  |  HT     | STD   | STDERR
PSB 313 | 40   | 95.475  | 18.6121 | 2.94283
2+0 BR   | 30   | 67.9333 | 17.1302 | 3.12753
2+1 BR   | 40   | 90.575  | 19.2592 | 3.04515
1P + 1   | 40   | 85.7    | 26.1104 | 4.12842

STOCK  | VAR  | CV       | MIN | MAX
PSB 313 | 346.41 | 19.4942 | 53  | 125
2+0 BR  | 293.444 | 25.2162 | 28  | 114
2+1 BR  | 370.917 | 21.2633 | 32  | 120
1P + 1  | 681.754 | 30.4672 | 40  | 146

"SX81104Q -- STOCK TRIAL -- WANSALAKE" 9
"ANALYSIS FOR HT"
16:36 WEDNESDAY, MARCH 5, 1986

GENERAL LINEAR MODELS PROCEDURE

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE: HT
NOTE: THIS TEST CONTROLS THE TYPE I COMPARISONWISE ERROR RATE,
     NOT THE EXPERIMENTWISE ERROR RATE.

ALPHA=0.05 DF=146 MSE=432.014

WARNING: CELL SIZES ARE NOT EQUAL.
HARMONIC MEAN OF CELL SIZES=36.9231

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

DUNCAN GROUPING  MEAN  N  STOCK
A    95.475  40  PSB 313
A    90.575  40  2+1 BR
A    85.700  40  1P + 1
B    67.933  30  2+0 BR
### GENERAL LINEAR MODELS PROCEDURE

**DEPENDENT VARIABLE: RCD**

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
<th>F VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>3</td>
<td>526.55523333</td>
<td>175.51841111</td>
<td>11.64</td>
</tr>
<tr>
<td>ERROR</td>
<td>146</td>
<td>2201.15916667</td>
<td>15.07643265</td>
<td>PR &gt; F</td>
</tr>
<tr>
<td>CORRECTED TOTAL</td>
<td>149</td>
<td>2727.71440000</td>
<td>15.84800000</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R-SQUARE</th>
<th>C.V.</th>
<th>ROOT MSE</th>
<th>RCD MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.193039</td>
<td>24.5005</td>
<td>3.88283822</td>
<td>15.84800000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>TYPE I SS</th>
<th>F VALUE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOCK</td>
<td>3</td>
<td>526.55523333</td>
<td>11.64</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>TYPE III SS</th>
<th>F VALUE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOCK</td>
<td>3</td>
<td>526.55523333</td>
<td>11.64</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
### GENERAL LINEAR MODELS PROCEDURE

**DEPENDENT VARIABLE: HT**

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
<th>F VALUE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>3</td>
<td>14223.556666667</td>
<td>4741.18555556</td>
<td>10.97</td>
<td></td>
</tr>
<tr>
<td>ERROR</td>
<td>146</td>
<td>63074.016666667</td>
<td>432.01381279</td>
<td></td>
<td>PR &gt; F</td>
</tr>
<tr>
<td>CORRECTED TOTAL</td>
<td>149</td>
<td>77297.573333333</td>
<td>432.01381279</td>
<td></td>
<td>0.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R-SQUARE</th>
<th>C.V.</th>
<th>ROOT MSE</th>
<th>HT MEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.184010</td>
<td>24.1536</td>
<td>20.78494197</td>
<td>86.05333333</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>TYPE I SS</th>
<th>F VALUE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOCK</td>
<td>3</td>
<td>14223.55666667</td>
<td>10.97</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>TYPE III SS</th>
<th>F VALUE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOCK</td>
<td>3</td>
<td>14223.55666667</td>
<td>10.97</td>
<td>0.0001</td>
</tr>
</tbody>
</table>