COMPARISON OF GROWTH OF LODEPOLE PINE STOCK TYPES

IN THE QUÉSNEl TIMBER SUPPLY AREA

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Abstract:

This experiment analyzed the field performance of *Pinus contorta* (lodgepole pine) seedlings in the Quesnel Timber Supply Area. Two different stock types, PSB 211 container stock and 2+0 bareroot, from three nurseries, namely Vernon, Red Rock and Ruff nurseries, were analyzed using the one way analysis of variance technique and compared using Duncan's New Multiple Range test. The statistics used for the analysis were the height and diameter increases over a single growing season. The results indicated that the PSB 211 container stock from the Vernon and Ruff nurseries had significantly greater height and diameter increases and thus better growth than the 2+0 bareroot seedlings from the Red Rock nursery. Also, the Vernon and Ruff nursery container stock were not significantly different in their height and diameter increases. Initial seedling vigor was probably the most influencing factor on seedling growth in this experiment.
Acknowledgements:

Sincere thanks should go to Denise McGowan for her data collection, her information on the site, and for her making available the data to analyze. I would also like to thank Mary Lester for initiating the experiment and allowing me to analyze the experiment.
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Introduction:

This report analyzes the data of an Sx trial in the Cariboo/Quesnel Forest District (Appendix G). The number of this trial registered in the Silviculture Branch of the Ministry of Forests in Victoria is Sx 85117C. In this experiment, the seed from seedlot 4248, Lodgepole Pine, was planted in three different nurseries to produce two seedling stock types. These stock types were transplanted on the test site and one year's growth of the three nursery stock types was compared. The growth parameters that were measured were increase in height and diameter of the seedlings since these parameters are relatively cheap and easy to measure.

Literature Review:

Field performance testing of bareroot and container stock types has been done on a variety of species and a variety of sites in North America. The U.S. Forest Service testing program in Washington and Oregon began in 1969 with about eighty sets of plots established in a variety of forest types (Lavender, 1986). The results from these and other tests concerning field performance have indicated that percent survival varies significantly from test to test due to the variability of sites and weather conditions. However, survival comparisons are none the less useful in determining a suitable planting
stock for reforestation.

The U.S. Forest Service testing has shown lodgepole pine bareroot stock types to have better survival over container stock in central, eastern, and southwestern Oregon. However, these results are from areas with high populations of ground squirrels and deer, and such areas have been found to be inappropriate for container seedlings (Cleary, Greaves, Herman, 1976). The U.S. Forest Service results are contradicted by a different study. In the interior of B.C., Dobbs (1976) reported that the survival of lodgepole pine container seedlings on most test plots was better than nearly all of the bareroot grades planted.

Another factor which influences the field performance of artificial regeneration is the initial size of the seedling planted. Many studies, such as Scarratt (1972), Arnott (1972), Hocking and Endean (1974), Endean and Hocking (1973), and Hines and Long (1986), have proven that seedlings with larger initial diameters and heights have significantly greater survival percentages than seedlings with smaller initial diameters and heights. On the contrary, recent studies in southwest Oregon on hot dry sites have shown smaller Douglas-fir (Psuedotsua menziesii) container stock may have as high as 92 percent survival after two growing seasons as opposed to 57 percent survival for larger 2+0 bareroot seedlings (Lavender
1986. This is also supported by the work of Hahn (1982) with Douglas-fir seedlings.

From all these different studies and tests, it is apparent that field performance testing should be done on a more site specific basis because there is so much variation among sites.

III Methods and Data Analysis:

The area in which the data was collected is located in the Quesnel Timber Supply Area, about fifty-six km east of Quesnel, B.C. The site is in West Fraser Mills Limited Forest Licence A20005 in the Cariboo Quesnel Forest District, near Sovereign creek, southwest of Campbell Mountain in the Cottonwood Supply Block of the Quesnel T.S.A. (see Appendices E and F).

The site is situated in the Englemann Spruce-Subalpine Fir biogeoclimatic zone on a southeast facing gentle slope. The moisture regime is somewhat sub-xeric and the nutrient regime is mesotrophic.

The area was logged in 1982, broadcast burned in 1983 to create a more uniform plantable area, and the trial seedlings were planted in June 1984.

The problem that this experiment tried to solve was one of comparison. The field performance of two seedling stock types grown from the same seedlot and planted in three different nurseries were compared.
The species tested was *Pinus contorta* (lodgepole pine). The seedling performance was analyzed using the increase in height and diameter of the seedlings as the variables measured.

There were two factors which were varied in the experiment. One was the stock type and the other was the nursery in which the seedlings were grown. There were two different stock types compared: PBS 211 container stock and 2+0 Bareroot seedlings. The PSB 211 stock was grown in two different nurseries, namely the Vernon nursery in Vernon, B.C. and the Ruff nursery in Prince George, B.C. The other stock, 2+0 bareroot, was grown at the Red Rock nursery in Prince George, B.C. The comparison was done on the three different nursery/stock type combinations.

The design of the experiment is called a Completely Randomized Design and it is a design in which there is no restriction on the allocation of treatments. The treatments under consideration were the three different nurseries in which the seedlings were originally grown in:

- A  Ruff  PSB 211
- B  Vernon  PSB 211
- C  Red Rock  2+0 BR.

It was decided to plant seventy-five seedlings of each treatment, and this seventy-five was divided into three
groups of twenty-five seedlings, with each seedling constituting one observation in the experimental analysis. The physical layout of the experiment was:

B A A C B B C C A.

Each letter represented a single row of twenty-five seedlings. The rows were spaced two metres apart and seedlings were given two metre spacing in each row. The mathematical model used for this experiment was:

\[ V_{ij} = \mu + \tau_j + \epsilon_{ij} \]

where \( V_{ij} \) represented the \( i \)th seedling (\( i=1, 2, \ldots, n_i \)) on the \( j \)th treatment (\( j=1, 2, 3 \)) and \( \mu \) was the common effect for the whole experiment (the population mean), \( \tau_j \) represented the effect of the \( j \)th treatment, and \( \epsilon_{ij} \) represented the random error present in \( i \)th seedling on the \( j \)th treatment. With this model in mind, the hypothesis \( H_0 : \tau_j = 0 \) for all \( j \), was tested to find out whether a treatment effect existed (i.e. if at least one of the treatment (nursery/stock type combination) means was significantly different).

As mentioned before, data were collected on the height, diameter, and vigor of the seedlings in fall of 1984 (Appendix A). The height of each seedling was measured using a straight edged ruler, and the vertical distance between the root collar and the apical terminal bud tip was recorded. If a leaning seedling was thought to have the ability to right itself eventually, then the
stem distance between the above mentioned two points was recorded. Diameter was measured by a set of calipers placed at the root collar. The vigor was described as follows:

G-Good  -good growth and vigor
         -no sign of stress
         -no damage

M-Medium -good growth and vigor
         -signs of stress
         -no damage

F-Fair   -poor new growth
         -damage; broken top, lateral branches
         -will live

P-Poor   -little to no new growth
         -most needles are brown
         -will not live

D-Dead   -dead.

The second set of data was collected in the Fall of 1985. Again, height, diameter, and vigor were recorded and results are in Appendix B.

From the two sets of data, the change in height and diameter were calculated (Appendix B) and were used for the analysis. The one way analysis of variance technique (Hicks, 1982; Walpole, 1982) was used to analyze the data. The analysis tested the treatment effect to determine if this effect did in fact exist. The computations for this analysis can be found in Appendix C. The analysis of variance for the change in height is shown in table 1 and for the change in diameter in table 2.

The F values calculated were compared with the
<table>
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<th>DF</th>
<th>MS</th>
<th>F</th>
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<td>442.1635</td>
<td>11.07</td>
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<td>Error</td>
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<td>182</td>
<td>39.9248</td>
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<td>Total</td>
<td>8150.6486</td>
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Table 1: The analysis of variance for the change in height. The critical F value at the 0.05 significance level is 3.05.

<table>
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<th>Source of Variation</th>
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<th>MS</th>
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<td>Error</td>
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<tr>
<td>Total</td>
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Table 2: The analysis of variance for change in diameter. The critical F value at the 0.05 significance level is 3.05.
critical values and both F's were found to be significant, which meant that at least one of the nursery/stock type combination means was significantly different. Thus, it was useful to figure out which nursery/stock type combination mean differed significantly by doing Duncan's New Multiple Range Test (Walpole, 1982) on the means. The calculations for this can be found in Appendix D.

Conclusion and Discussion:

The results of the analysis of variance indicated that at least one of the nursery/stock type combination means was significantly different. The Range test then compared the nursery/stock type combination means, and found that the 2+0 bareroot seedlings grown in the Red Rock nursery had significantly lower increases in height and diameter over the single growing season tested than the other two nursery/stock types. In other words, the results indicated that the container stock from the Vernon and Ruff nurseries had significantly greater height and diameter increases and thus better growth than the bareroot seedlings from Red Rock nursery.

In order to determine why a significant difference was found, we must look at factors that were varied and how they could affect the growth of the seedlings. The two factors that were varied were the nurseries and the stock types.

The first factor, the nurseries, was an interesting
and difficult factor to analyze. Since the seedlings were from three different nurseries, one could expect that the seedlings received somewhat different treatments while in the nursery, and different nursery treatments would have resulted in different survival and growth of the planted seedlings. Date of sowing seed, irrigation schedules, root pruning, wrenching, seedling nutrition, seedling harvest method, and seedling storage would have varied with the different nurseries and each would have influenced the growth and vigor of the seedlings. For example, McDonald (1983) discovered that an early planting date had the strongest influence on survival and growth, with the early plantings performing better than the late. Also, proper irrigation schedules must be maintained in order to maximize photosynthesis and to induce dormancy and frost hardiness at the appropriate time of the year. Lifting date and storage were reported by McDonald (1983) and Morby (1979) to be important nursery practices. Both found autumn lifting, cold (−3°C) storage, and spring planting to produce the best growth and vigor. Ekwebelam (1983) also reported that light, nutrition, and mycorrhizal fungi also affected seedling growth and vigor. Thus we can conclude that the nursery effect was very complex. It was difficult to determine what effect the nurseries had on the growth and vigor of the seedlings since no data were collected on the
nursery practises. This was definitely one shortfall of this experiment.

However, there was the possibility of comparing location, in a broad sense, in this experiment. Both the Ruff and Red Rock nurseries are located in Prince George, B.C. which is in the Sub Boreal Spruce biogeo-climatic zone. We would expect that these two nurseries received the same external environmental factors such as amount of precipitation, amount of sunlight, daylengths, and the same temperature regime. The Vernon nursery, located in Vernon, B.C. in the Ponderosa Pine - Bunchgrass zone has a distinct semi-arid climate which is definitely different than the Boreal climate of the other two nurseries. Since the Vernon and Ruff nurseries, which produced the same container seedlings, were not significantly different in their growth, different nursery locations were probably not a significant factor in this experiment. Even though this experiment found the different nursery locations not to be a significant factor, many examples have shown that it is best to plant the seedlot in the nursery nearest to the site which is to be reforested.

The other factor which was varied was the stock types. As discussed in the Literature Review section of this report, many studies have been done on the field performance of container stock versus bareroot seedlings.
Some reports have shown bareroot seedlings to have better survival over container seedlings (Lavender, 1986), and other reports have indicated the opposite (Dobbs, 1976). However, if we look at the problem on a more site specific basis, we find that the container seedlings have done better on this dry site, and this agrees with work done in Oregon (Lavender, 1986) and in B.C. (Hahn, 1982).

The initial size of the seedlings may have also affected the growth of the stock types as mentioned in the Literature Review. The bareroot root seedlings from Red Rock nursery definitely have a larger mean diameter than the container stock, and thus would be expected to have better growth. This would agree with the recent work done by Hines and Lang (1986) who found large initial diameters decreased seedling susceptibility to bending and breaking by snow on engelmann spruce (*Picea engelmannii*), and work by Endean and Hocking (1973) on lodgepole pine. However, we found the opposite to be true in this experiment. To account for this, we looked at the initial vigor of the seedlings in Appendix A. Here we found that the bareroot stock had the poorest initial vigor, with eighteen percent of the bareroot stock being dead at the beginning of the experiment. The quality of the two container stock was markedly better with over ninety percent of both container stocks being of either good or medium vigor, while only forty-
seven percent of the bareroot stock had this same vigor. It was apparent that the bareroot stock was of poor quality to begin with, and therefore we found that the bareroot stock had the poorest growth over the growing season. Thus, initial seedling vigor was probably the most influencing factor on the growth of the seedlings in this experiment.

The fact that no data were collected on the nursery practises has already been mentioned as one of the shortfalls of this experiment, but this was not the only shortfall. This experiment only measured the above ground data available and neglected to record any growth or accumulation of biomass done by the roots. It would seem to be especially important to observe the root growth on this site since the moisture regime is dry. Roots would most likely be the major sink of energy and carbohydrates on this dry site because the seedling would need a superior root system to better exploit the soil for moisture. This would help the seedling to better survive periods of severe moisture stress that it would experience on this site. Hines (1986) found in his report that more than ninety percent of first season mortality of engelmann spruce was caused by drought. Carlson (1986) indicated that nursery practises that favoured the production of seedlings with large root volumes and high root growth potentials would increase
the quality of seedlings. Therefore, with this evidence, it seemed that neglecting to observe the root growth was another shortfall of this experiment.

Conclusions from this experiment should only be applied to our site in question. The results of an experiment such as this could be improved by a few changes in the design and set-up of the experiment. More useful results would have been attained if both container and bareroot stock were grown in each of the three nurseries. The design of the experiment would be changed to a Randomized Complete Block Design, with the seedling stock types being the treatments and the three nurseries being the blocks. Another way to attain more useful results would be to replicate the experiment on different sites. The results from such an experiment would yeild more general conclusions that could be applied in a more variety of ways.
Literature Cited


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McDonald, S.R. "Lifting, storage, planting practices influence growth of conifer seedlings in the Northern Rockies." Research Paper, Intermountain Forest and Range Experiment Station, USDA Forest Service, No. INT-300, 1983.

Morby, F.E., and Ryker, R.A. "Fall-lifted conifers successfully spring planted in Southwest Idaho." Tree Planters' Notes, 30, No. 3 (1979).


SX TRIAL SUMMARY

SX 85117C

TITLE: Comparison of Growth of Stock Types of Seedlot 4248, Lodgepole Pine.

OFFICER I/C: A. Waters, West Fraser Mills Ltd., Quesnel

LOCATION: Forest Licence A20005, C.P. 437, Sovereign Creek

REGION/DISTRICT: Cariboo/Quesnel

OBJECTIVE: To compare the field performance of stock types grown at three different nurseries in B.C.

PROGRESS: Trial established June, 1984, assessed June, 1986. After two growing seasons, PSB 211 container stock of lodgepole pine from Vernon and Ruff Nurseries had significantly higher height and diameter growth than the 240 bareroot seedlings from Red Rock Nursery.

NEXT SCHEDULED ASSESSMENT/TREATMENT: Project discontinued

REPORT DISTRIBUTION: Silviculture Branch Library, Victoria
Cariboo Forest Region
Quesnel Forest District

COMPLETE

JANUARY, 1990