Morice & Lakes IFPA

March 2002
Summary No. 4

Morice & Lakes Innovative Forest Practices Agreement

PROJECT SUMMARY

Morice & Lakes IFPA projects are exploring ways to enhance forest productivity through a better understanding of factors affecting productivity, through intensive silviculture treatments, by increasing the area of productive forest land, and by improving site productivity estimates.

Genetic Improvement: Interactions with Silviculture and Disease

Introduction

Tree improvement is widely viewed as a cost-effective method of increasing forest productivity. The lodgepole pine breeding program in BC is well established, and predicted gains in individual tree growth rates are substantial and verifiable. The area planted with genetically improved seedlings is expected to increase considerably over the next decade.

This genetics project was carried over to the Morice and Lakes IFPA from the Babine Forest Products Enhanced Forest Management Pilot Project. It focuses on:

1. the interaction of stocking density with crown architecture, and their independent and joint effect on growth performance; and
2. genetic control of susceptibility of lodgepole pine to comandra rust (*Cronartium comandrae* Pk.).

Objectives

Tree improvement programs often consider genetics separately from other factors affecting growth, such as silviculture and disease. It is assumed that tree growth on one or a few test sites will predict the true genotypic potential. However, silviculture may affect the performance of genetically improved stock. Some previous studies, show that the best genotypes under one set of conditions may not be optimal under different conditions. Stocking density, for example, could affect the ranking of genotypes through genetic differences in competitive ability.

Timber losses to disease, particularly comandra rust (see Figure 1), are large in the Morice and Lakes TSAs. Assessments in progeny tests can reveal whether some families are resistant to a given disease. Existing lodgepole pine tests in the Bulkley Valley provided an excellent opportunity for obtaining estimates of disease resistance levels, particularly because infection levels on one site are high. Identification of resistant genotypes can help in developing deployment strategies for improved stock in disease-prone areas.

This project focuses on two questions relating to genetics, silviculture and disease resistance of lodgepole pine in the Morice and Lakes TSAs, namely:

1. Should the choice of families for operational deployment depend on factors such as plantation spacing and variation in crown structure among families?

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2. Are some pine trees “naturally” resistant to comandra rust, and does this resistance have a genetic basis?

The answers to these questions may link silvicultural practices more closely to breeding and selection, thus improving their effectiveness, and may also allow production and deployment of disease resistant planting stock. This would enhance the productivity of the forest land base by increasing wood production and by reducing losses to disease.

Figure 1. Diamond-shaped stem canker of comandra rust on a young lodgepole pine in the Bulkley Valley (photo: S. John)

Methods

Genetics and silviculture

Data from existing BC Ministry of Forests trials were analyzed earlier to confirm the existence of genetic variation in harvest index, or proportion of biomass contained in the bole of the tree. This was followed by assessments of crown architecture in existing progeny tests in the Bulkley Valley. Three contrasting crown types were identified (see Table 1), and six families, two of each type, were selected.

In the spring of 2001, an espacement study was established on one test site in the Bulkley Valley, using seedlings grown from remnant seed of the six selected families. This study will investigate the relative performance of families with different patterns of biomass allocation and crown architecture when grown under a wide range of planting densities.

Thirty-six plots of 64 trees, at spacings of 0.6 to 2.4 m (0.36 m^2/tree to 5.76 m^2/tree), were established. Fill planting to replace mortality will be done in the spring of 2002, and measurements will commence when crown competition is imminent.

Genetics and disease

One site of the Bulkley Valley progeny trials was assessed for comandra rust in 2000. Since this trial, established in 1985 and 1986, was not designed for the purpose of disease assessment, numbers of seedlings/family and their spatial arrangement were not adequate to ensure high accuracy of family rankings. Despite these design implications, variation in infection rates among families was large and significant. Variation in resistance also has a clear geographical basis. Cluster analysis of geographic data revealed that trees grown from seed from some areas of the province had far higher infection rates than others.

A new trial is planned, designed specifically to test comandra resistance of genotypes established in the Bulkley Valley seed orchard located at the Vernon Seed Orchard Company orchard site, and to allow accurate ranking of families. Fifty open-pollinated families were collected from the orchard in the fall of 2001; further families from this 65-clone orchard will be collected when available. Seedlings grown from this seed will be established in a tightly spaced (1m x 1m) trial replicated on three sites, chosen for high likelihood of comandra rust exposure.

Table 1. Crown form traits of three contrasting crown types

Crown form traits	Type 1:	Type 2:	Type 3:
Harvest index	• high harvest index	• intermediate harvest index	• low harvest index
Branch length and distribution	• short branches in both upper and lower crown	• long branches in upper crown, shorter branches in lower crown	• long branches in both upper and lower crown
Distribution of biomass	• most biomass clearly allocated to tree bole	• intermediate biomass clearly allocated to tree bole	• large proportion of biomass allocated to tree branches

Results

Genetics and silviculture

Existing Ministry of Forests harvest index data for 60 lodgepole pine families with parental elevations ranging from 600 m to1650 m in a farm-field test were analyzed. Significant differences were found among families in harvest index, even when corrections were made for tree size and elevation. In other words, there is real variation in biomass allocation patterns among families from similar elevations.

Assessment of crown form in existing progeny tests in the Bulkley Valley confirmed that variation in crown architecture exists, and allowed selection of two families of each of three contrasting types for establishment in a field spacing trial. No results are yet available from this spacing trial, established in 2001.

Genetics and disease

As noted above, families showed large variation in resistance to comandra rust (see Figure 2). Infection rates by family varied from 0% to 69% of trees infected. Later analyses explored the geographic basis for family variation. Surprisingly, the elevation of the original mother tree had no influence on whether a given family was resistant to comandra rust. Infection rate is, however, clearly influenced by geographic source, with the highest infections rates occurring in families from low latitudes and longitudes.

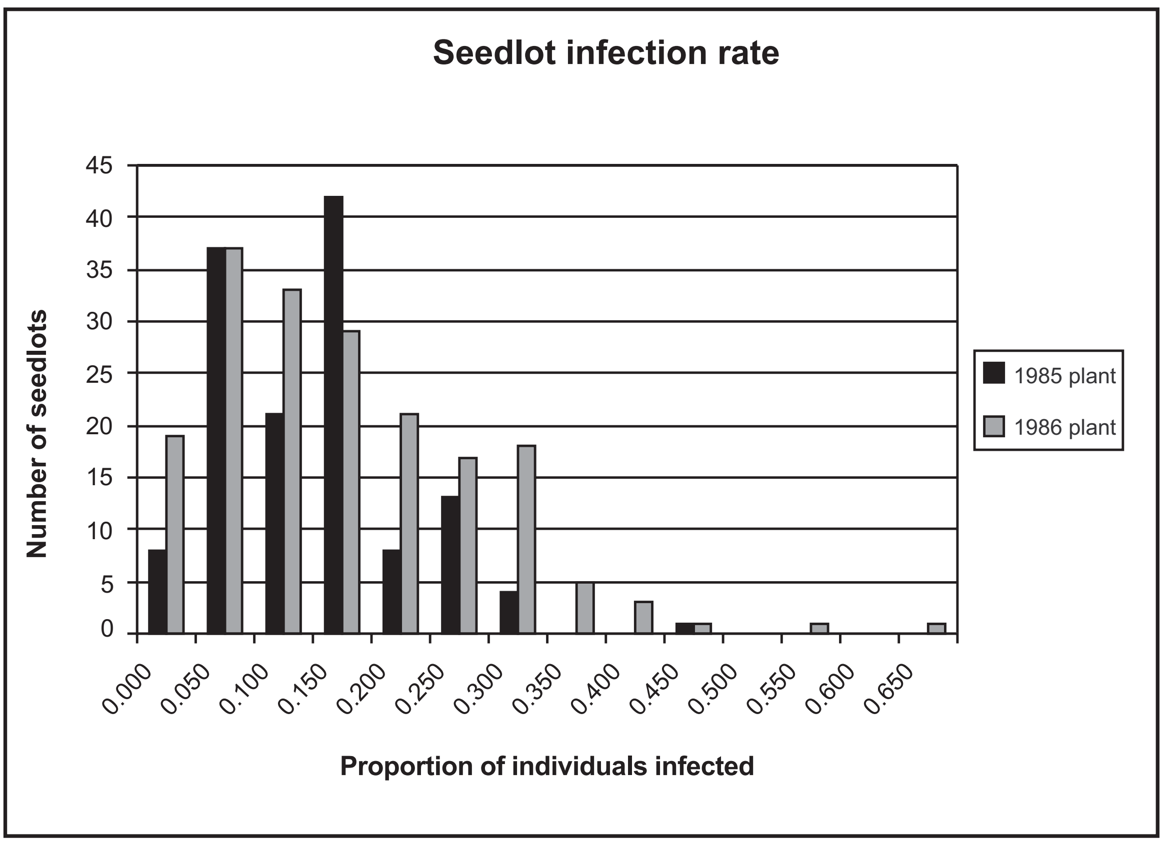

Figure 2. Seedlot infection level distribution, both years of planting.

Discussion

The espacement study implemented under this project may influence the design of future genetic tests, through recognition of the role of crown architecture in influencing growth performance. This may suggest that trials should be tailored to specific silvicultural conditions, rather than relying on the assumption that performance is unchanged by factors such as spacing.

The results of the comandra assessments have already been integrated into forestry practice, with the designation by MOF of several provenances of lodgepole pine as "comandra resistant" and therefore suitable for deployment in high-risk areas. As further tests are established and analyzed, the potential for precise site-seedlot matching will be increased.

The comandra trials established under this project are also expected to enable seed orchard production of resistant seedlots for deployment in high-risk areas.

Conclusions

The results of the studies summarized here will facilitate production and deployment of comandra-resistant planting stock. They may also result in modifications to breeding and selection methodology by linking them more closely to silvicultural practices. The productivity of the forest land base would thus be enhanced by increasing wood production and by reducing losses to disease.

Recommendations

- Ensure that tests established under this project are maintained and measured through the short and medium term (up to 20 years).
- Ensure that all clones in the Bulkley Valley seed orchard are included in comandra screening tests.

References

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Acknowledgements

This project was made possible through funding by Forest Renewal BC and through partnership with the Ministry of Forests. The support and assistance of Dr. Michael Carlson, Ministry of Forests lodgepole pine breeder, is gratefully acknowledged. Valuable information and advice was provided by Alex Woods and Richard Reich, BC Ministry of Forests, and by Bart van der Kamp, UBC.

This summary was written by Sally John and edited by John Young. Additional editing and layout was by Ritchie Morrison of Tetrad Consulting.

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