

**LODGEPOLE PINE DWARF MISTLETOE
SPACING TRIALS
1988 PLOT REMEASUREMENT**

by

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FOREWORD

This report is one of a series of internal reports distributed by Forest Protection Branch, B.C. Ministry of Forests, to record accomplishments and interim or provisional results for the information of staff, colleagues, and others.

In the Canada-British Columbia Forest Resources Development Agreement (FRDA) 1985 to 1990, over 100 pest control projects were directly funded by the province and administered by protection staff. To facilitate application of the results, and development of improved forest health management strategies, the contractors reports have been edited and distributed as internal reports. Accordingly, any opinions and recommendations expressed are those of the contractor, and not necessarily those of the ministry or the FRDA management committee.

For details or more information about the report or project, please contact forest health staff at Protection Branch or at the forest region offices.

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The guidelines for internal reports outlined in the Protection Manual were adhered to as closely as possible. All manuscripts were altered to comply with a common format, but entire reports were not rewritten to conform to a standardized outline.

Most Executive Summaries were the work of Graham Hawkins of MoF Inventory Branch (formerly with Pacific Coast Forest Biology). All word processing was accomplished by Catriona Kaufman of Top Kat Services. Will Gordon of R. White Woods inc. prepared all maps and figures.

R. White, editor
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EXECUTIVE SUMMARY

The project objective was to remeasure trees to determine the effect of spacing in a young dwarf mistletoe-infected lodgepole pine stand.

A spacing trial area was established in a 30-year-old lodgepole pine stand at Pelican Road (km 38) under a non-FRDA-funded project (PM-PG-9) in 1987. The purpose of this study was to determine the effectiveness of sanitation spacing compared to spacing without regard to dwarf mistletoe areas and with no treatment. Three blocks were laid out and three permanent sample plots (PSPs) were established in each of these blocks. One block was located in a heavily infected area, and two blocks (one spaced and one control) were established in lightly infected areas. The blocks were to be monitored every year for comparisons of dbh, height, number of infections and production between treated and non-treated.

In September 1988, the first of these block remeasurements were performed during this project. Height, diameter and percentage live crown were estimated on all plot trees. Mistletoe infection was measured using the six-class dwarf mistletoe rating (DMR) method. Photographs were taken in each block for a visual record of response to treatment.

The percentage of trees attacked remained almost the same, except in the unspaced, lightly infected block, which exhibited an increase of 26%. A significant difference in dbh, height and branch infections was noted between the healthy and infected blocks and between lightly and heavily infected blocks, as had been previously noted during establishment of this trial. In the heavily infected block, the unspaced treatment had fewer branch infections. This increase was not observed in the lightly infected block. Production was observed to be less in the heavily infected block than in the healthy (control) or lightly infected blocks, but no significant difference in diameter was evident. Tree height was shown to be an unreliable predictor of branch infection severity. Although initially determined differences were verified, results were considered to be tentative because two years is too brief a period within which responses to spacing can be quantified.

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1 INTRODUCTION

Spacing trials in dwarf mistletoe-infested lodgepole pine were established in Prince George West Forest District in 1986. The purpose of the trials was to determine the effect of spacing in a heavily infested stand and a lightly infested stand (Lewis 1987). Remeasurement of the trees in the plots is necessary to observe the changes that occur in the stands over time. In September 1988, the first of the plot remeasurements was performed.

2 MATERIALS AND METHODS

2.1 Tree Measurements

Height and diameter at breast height (dbh) were measured and percent live crown was estimated on all trees in each plot (dbh was measured only on trees greater than 5.0cm diameter to be consistent with the 1986 data). Heights were measured using a Suunto clinometer and measuring tape for all trees. This contrasts with the 1986 method, where most of the tree heights were estimated.

2.2 Mistletoe Data

The number of branch infections were counted on each tree; only infections with shoots were tallied. Stem infections were also counted and categorized by location (lower, middle or upper third of the stem). Other diseases or scars were also noted.

2.3 Photographs

Photos were taken using a wide angle (49mm) lens from the photo points listed below.

Photo	Block	Plot or Corner	Direction
1 and 2	3	NW	SE
3	3	SW	NE
4	2	SE	NW
5	2	3	N
6	2	NW	SE
7	2	NW	SW

3 RESULTS

Trees in Block 1 still remain free of mistletoe infections, but the number of infections in Blocks 2 and 3 have increased greatly. Table 1 shows a summary of the 1988 data, and Figure 1 compares the incidence and number of infections between 1986 and 1988.

The percentage of trees attacked by mistletoe remained fairly constant over the two years, except in Block 2C (unspaced, lightly infested) where the percent of trees attacked increased from 23-59%.

The majority of the stem infections were located on the lower third of the stem which suggests that the infections occurred early in the life of the stand from the infected residual trees overhead. The top third of the trees had the fewest infections.

Orthogonal Contrasts (Ostle 1963) are a means of statistically comparing treatments using predetermined contrasts (i.e., determined at the time of experimental design). These contrasts were performed on the 1988 data, as they were on the 1986 data, and are shown in Table 2. The contrasts are between the negative and positive contrast coefficients. For example, C1 compares the unspaced/healthy block to all the remaining blocks. C3 contrasts the spaced/light infestation to the unspaced/light infestation. Rough calculations are included in the appendices. Appendices are not included with this distributed report but are kept with the original document in the Forest Health Section, MoF Protection Branch, Victoria. Contrast 1 shows a significant difference in dbh, height and branch infections between the healthy block and the infested ones, which is consistent with the establishment results. There is also a highly ($P = 0.01$) significant difference in all three variables between the lightly and heavily infested blocks. Currently, there is no significant difference in height and dbh between spaced and unspaced blocks, except in the heavily infested block, which shows a significant ($P = 0.05$) difference in the number of branch infections between the spaced and the unspaced treatment, the unspaced treatment having fewer branch infections. The treatments and variables which show significant differences with the means have not changed since 1986, but the levels of significance have changed for several contrasts.

Productivity indices (PI)(Johnstone 1976) are another means of comparing treatments. The indices are based on observed heights relative to expected stand heights which are adjusted according to stand density. A PI of 1 represents medium productivity at a specific density. Mistletoe infections, especially severe ones, are expected to lower stand productivity. Data from 1988 were used to calculate PI's, which are shown in Table 3. PI calculations are included in the appendix. Productivity is less in the heavily infested block than in the lightly infested or healthy block, as to be expected.

Comparisons in diameter measurements and the number of branch infections were made using Students' *t* tests (see appendix for calculations). These are summarized in

Table 4. Height measurements were not compared because all tree heights were measured in the 1988 data, and most were estimated in 1986. No difference in dbh is evident at this point in the experiment, but there has been a significant increase in the number of branch infections observed in 1988 compared to 1986 for all blocks, except the healthy/unspaced and the heavily infested/unspaced.

The final analysis was to determine whether or not there is a relationship between tree height and the number of branch infections based on the hypothesis that trees with most of their branches low in the canopy are more exposed to mistletoe seeds. Simple linear regressions were performed on the 1988 data by treatment block with tree height as the independent variable and number of branch infections as the dependent variable. Both Analysis of Variance and the Coefficient of Determination (R^2) were used to test the significance of the regression. The results of F tests showed a significant regression for Blocks 2 (spaced/light infestation) and 3C (unspaced/heavy infestation), but the correlation coefficients (r^2) for both were quite low. Therefore, tree height was shown to be an unreliable predictor of branch infection severity.

4 CONCLUSIONS

There have been no significant changes in tree growth since the establishment of the experiment, which is expected since two years is too short a time for the effects of spacing or of mistletoe infection to be expressed in tree growth. However, there have been significant increases in the number of branch infections. This may be due partly to the time of year the measuring was done (fall in 1988, early spring in 1986). The great increase in branch infections over two years in the spaced/heavily infested block, but not in the unspaced block, suggests that the spacing treatment has caused an increase in infection rate. The orthogonal contrasts support this because they show a significantly greater number of infections in the spaced/heavily infested block than in the unspaced block (1988 data only). If the increase in infections was due only to the time of year of sampling, there would be no difference between the spaced and unspaced treatments. This infection rate increase was not observed in the lightly infested block. At this early point in the experiment, spacing in lightly infested stands does not appear to increase the number of branch infections.

Overall productivity is much less in the heavily infested blocks, but is not significantly reduced in the lightly infested blocks. Stand productivity has decreased in both the spaced treatments and increased in the unspaced treatments, regardless of the level of mistletoe infestation. This is the reverse of what is expected with spacing treatments which may be due in part to the effects of mistletoe, but is probably a result of the short time for the spacing to have an effect sampling error. One interesting result is that the lightly infested block shows a lower productivity in the spaced treatment than in the unspaced control. Variable density tables used to calculate PI have higher expected tree heights for low density stands. In this case, the low density is due to spacing; therefore, productivity of the stand is expected to increase with time unless the mistletoe infections affect tree growth. Such effects will not be evident for several years yet.

A better measure of changes in tree growth due to spacing and/or mistletoe would be five-year radial growth increments, combined with changes in tree height. Radial increment changes allow a closer look at growth rate subsequent to treatments applied than does overall dbh.

In summary, this data shows that spacing has caused a greater increase in mistletoe infection in heavily infested stands than in lightly infested stands. Changes in tree growth and stand productivity due to the spacing treatment are not yet evident. Overall productivity and tree growth are reduced in the mistletoe-infested blocks in proportion to the level of infestation.

6 REFERENCES

- Johnstone, W.D. 1976. Variable-density yield tables for natural stands of lodgepole pine in Alberta. Canadian Forestry Service, For. Tech. Rep. 20. Ottawa.
- Lewis, J. 1987. The effect of spacing in a dwarf mistletoe infected stand of lodgepole pine. B.C. MoF Internal Report (PM-PG-9).
- Ostle, B. 1963. Statistics in research. 2nd ed. Iowa State Univ. Press. Ames, Iowa. 585pp.

**TABLE 1 LODGEPOLE PINE DWARF MISTLETOE PLOT
REMEASUREMENT**

Block	Plot	Mortality	Avg. Dbh	Avg. Height	% Trees Infect.	Avg. No. Infect.	
						Branch	Stem
1	1	0	9.1	9.3	0	0	0
1	2	0	9.3	9.1	0	0	0
1	3	0	11.5	12.5	0	0	0
Mean			9.9	10.1	0	0	0
2	1	0	8.8	10.2	0	0	0
2	2	1	7.2	9.0	90	3.3	1.2
2	3	0	7.1	8.4	64	3.4	0.2
Mean			7.7	9.1	19	2.3	0.5
2C	1	1	10.1	12.5	0	1.2	0
2C	2	0	11.2	10.3	47	0.7	0
2C	3	2	8.3	9.6	88	3.9	0.4
Mean			9.7	11.3	59	2.1	0.2
3	1	0	6.3	4.8	94	10.9	1.9
3	2	0	9.2	9.2	100	10.2	2.0
3	3	0	7.9	6.8	100	8.8	1.3
Mean			7.6	6.7	97	10.1	1.8
3C	1	0	7.8	4.8	100	4.7	1.1
3C	2	0	9.1	8.3	90	9.1	1.7
3C	3	1	7.7	6.3	83	3.1	1.2
Mean			8.3	6.5	89	5.1	1.3

**TABLE 2 ORTHOGONAL CONTRASTS COMPARING DBH, HEIGHT
AND NUMBER OF INFECTIONS BETWEEN TREATMENTS
— 1988 DATA**

Contrast	Contrast Coefficients				
	Treatments				
	Unspaced Healthy	Spaced light	Unspaced light	Spaced heavy	Unspaced heavy
C1	4	-1	-1	-1	-1
C2	0	1	1	-1	-1
C3	0	1	-1	0	0
C4	0	0	0	1	-1

F Tests				
Variable	Contrast	MS	F	Significance
DBH	C1	8896.27	14.23	**
	C2	9599.36	15.35	**
	C3	0.06	9.6 E-5	NS
	C4	859.21	1.37	NS
Height	C1	4699.35	6.00	*
	C2	15052.08	19.21	**
	C3	24.0	0.03	NS
	C4	0.17	0.0002	NS
Number Branch Infections	C1	9753.75	10.54	**
	C2	11346.75	12.26	**
	C3	96.0	0.10	NS
	C4	5460.17	5.90	*

* Significant at the 0.05 level

** Significant at the 0.01 level

TABLE 3 PRODUCTIVITY INDICES — 1988 DATA

Block	Treatment	PI '88	PI '86
1	healthy/unspaced	1.02	0.96
2	lightly infested/spaced	0.86	1.19
2C	lightly infested/unspaced	1.01	0.87
3	heavily infested/spaced	0.69	0.77
3C	heavily infested/unspaced	0.64	0.58

TABLE 4 COMPARISONS OF DBH AND NUMBER OF BRANCH INFECTIONS (NBI) BETWEEN 1986 AND 1988

Block	Variable	Mean		Significance
		1986	1988	
1	DBH	9.7	9.9	NS
2	DBH	7.7	7.7	NS
2C	DBH	9.3	9.6	NS
3	DBH	7.4	7.6	NS
3C	DBH	8.0	8.3	NS
1	NBI	0	0	NS
2	NBI	0.2	2.2	**
2C	NBI	0.4	2.1	**
3	NBI	3.3	10.4	**
3C	NBI	3.8	5.1	NS

FIGURE 1 **INCIDENCE AND NUMBER OF DWARF MISTLETOE**
INFECTIONS BETWEEN 1986 AND 1988

