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FOREST GROWTH
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Effects of planting on the growth and yield of reforested lodgepole pine stands

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Introduction

The Regenerated Lodgepole Pine (RLP) trial is an experiment to assess the effects of planting, weeding, and pre-commercial thinning on stand development following harvesting and planting of lodgepole pine. It has a split-plot design involving 102 whole-plots ("installations") planted at six different planting densities: 0, 816, 1111, 1600, 2500 and 4444 stems per ha. Each installation is divided into four sub-plots ("treatment plots"): control, weed, thin, and weed plus thin.

Mean annual increment (MAI) projected to culmination age is the criterion used for judging reforestation success on provincial Crown lands in Alberta. In order to estimate the effect of planting, we used GYPSY, a growth and yield model developed and approved by the Alberta government, to project merchantable MAI (at the 15/10cm utilization standard) from top height, age, density, percent stocking and basal area of lodgepole pine and hardwoods (trembling aspen and black poplar), measured on the RLP trial at an average stand age of 18 years. We then used a variety of statistical techniques to examine the variation in MAI attributable to planting.

Results

Merchantable MAI of lodgepole pine projected to culmination age is shown in Figure 1, averaged by target planting density class across weeded and non-weeded plots, with thinned plots excluded. (Weeded plots demonstrate higher yields, but there is no significant interaction between the weeding and planting effect i.e. the relative trend of MAI with planting density is similar with or without weeding). Increases of 2-14% in average MAI are indicated across the operational range of planting densities relative to the leave-for-natural ("0" planting) class; but only the intensive planting density of 4444 trees per ha (i.e. 1.5m square spacing) results in a significant increase of 36%.

Figure 1. MAI of lodgepole pine averaged by planting density. The "0" density class relies entirely on natural regeneration. The "4444" density is higher than is usual in operational practice.

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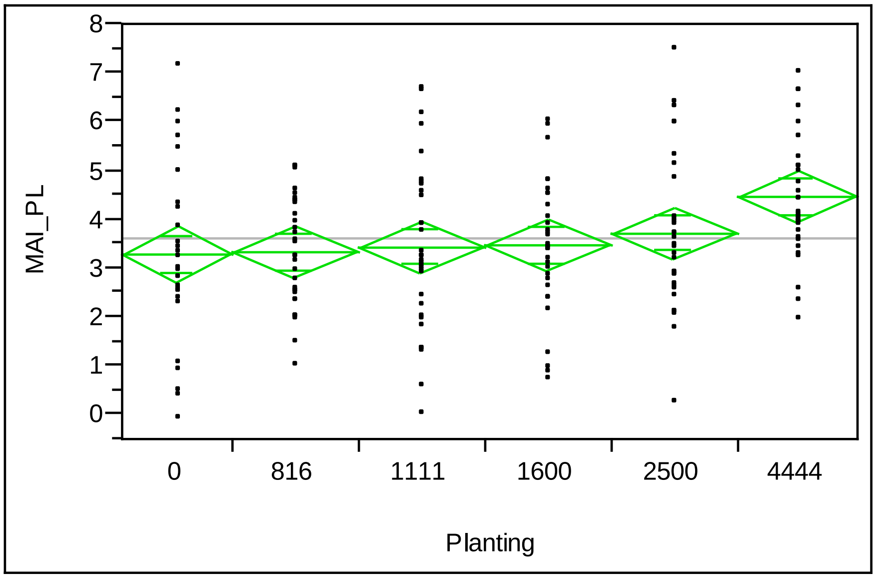

Figure 2. Variation in projected MAI. The black dots indicate individual sample plots and the grey horizontal line shows the overall sample mean. The green horizontal line across the middle of each diamond illustrates the class mean. The diamond's vertical span represents the class 95% confidence interval. The short lines above and below the mean are overlap marks. Overlapping marks between any two diamonds indicate that the two means are not significantly different.

Figure 2 illustrates the range, variation and confidence intervals around the MAI values shown in Figure 1. Only the highest density class shows a significant increase in MAI relative to lower densities, and the lower planting densities do not differ significantly to the leave-for-natural ("0" density treatment). There is much variation shown between plots within density classes, some of which can be explained by differences in site quality (e.g. soil regime) and treatment (e.g. site preparation, weeding).

We should be cautious in applying these results. Silviculturists typically plant lodgepole pine where stocking by natural regeneration is uncertain, or in order to deploy genetically improved growing stock. In the RLP trial percent stocking of pine at 18 years is influenced by natural sub-region, soil nutrient regime, site preparation, planting and other factors. It is significantly lower when natural regeneration rather than planting is relied upon, especially on rich versus medium or poor sites (see Figure 3).

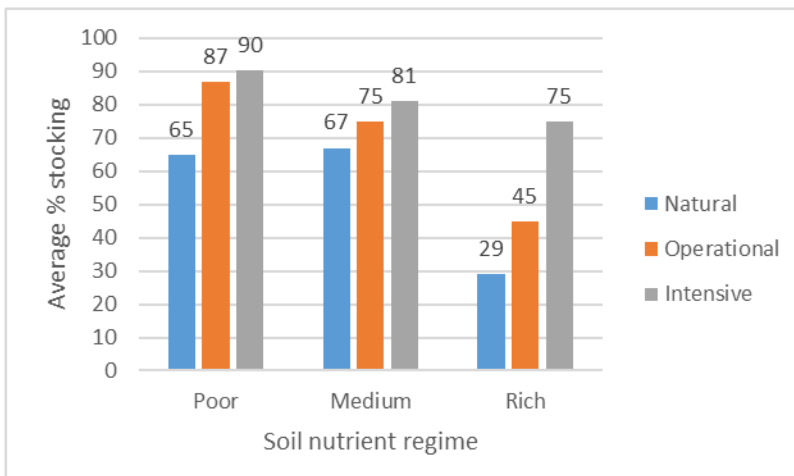

Figure 3. Percent stocking of pine in RLP trial control plots, averaged by soil nutrient regime and planting density group.

Conclusions

Although planting in the RLP trial over the normal range of operational densities does not significantly increase average MAI, it may be advisable on sites where natural regeneration is uncertain or likely to be poor. On such sites reliance on natural regeneration risks loss of site occupancy and hence of MAI. Trial results to date and projections by GYPSY suggest that intensive planting at high densities has the potential to increase growth and yield.

Caution: Long-term projections by GYPSY have not been, and currently cannot be, validated across the full range of stand conditions created by the experimental treatments of the RLP trial. This will ultimately be achievable by continued monitoring of the trial to rotation age.