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

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Introduction

The Regenerated Lodgepole Pine (RLP) trial was designed to assess the effects of planting, weeding, and pre-commercial thinning on stand development following harvesting and planting of lodgepole pine. It consists of 102 whole-plots ("installations") planted at six different planting densities. Each installation is divided into 4 sub-plots ("treatment plots"): control, weed, thin, and weed plus thin. Weeding was undertaken during the first 8 years after cut as required to keep hardwood densities below 1000 stems per ha. The actual treatment on plots designated for weeding usually involved chemical spraying at normal operational rates of glyphosate per ha on plots subject to hardwood competition, or no treatment on plots where competition was below threshold levels. Some plots, usually those with marginal hardwood densities, were weeded manually.

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 weeding, we used GYPSY, a growth and yield model developed and approved by the Alberta government, to project merchantable MAI (15/10cm utilization standard) to culmination age from top height, age, density, percent stocking and basal area of pine and hardwoods (trembling aspen and black poplar). We obtained these inputs by measuring the RLP trial 17 years after planting, at an average stand age of 18 years since cut.

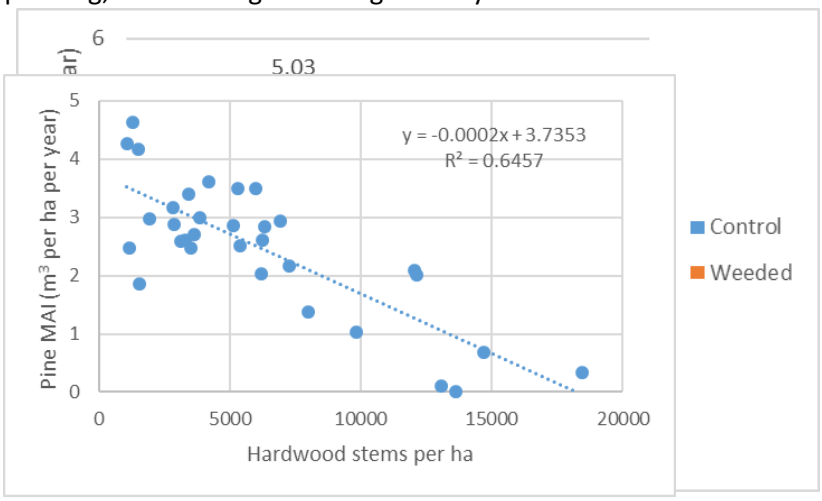

Figure 1. Effect of weeding on average pine MAI in stands with differing levels of hardwood competition.

Results

Figure 1 shows projected MAI for lodgepole pine averaged for control (i.e. untended) and weeded plots across installations with more and less than 1000 aspen and balsam poplar trees (≥1.3m in height) per ha in the control plots at the last measurement 18 years after cut, and about 13 years since last weeding. The increase projected from weeding plots in the lower density installations is not statistically significant, but in the >1000 class weeding more than doubles the average MAI. The average MAI in weeded plots in the >1000 class also exceeds that in the low-competition installations, presumably reflecting higher potential productivity on such sites. We observed similar relative trends of MAI with hardwood density across the full planting density

range, including stands left for natural regeneration. Results shown in Figure 1 are averaged across all planting densities. The projected MAI of pine declines with increasing aspen densities of over 1000 stems per ha, and high levels of hardwood competition may result in total elimination of pine timber yield (see Figure 2).

Hardwood density and competition increase significantly from the Upper to the Lower Foothills, and between poor, medium and rich sites (see Figure 3).

Figure 2. Relationship between juvenile hardwood density and projected pine MAI in RLP trial control (untended)

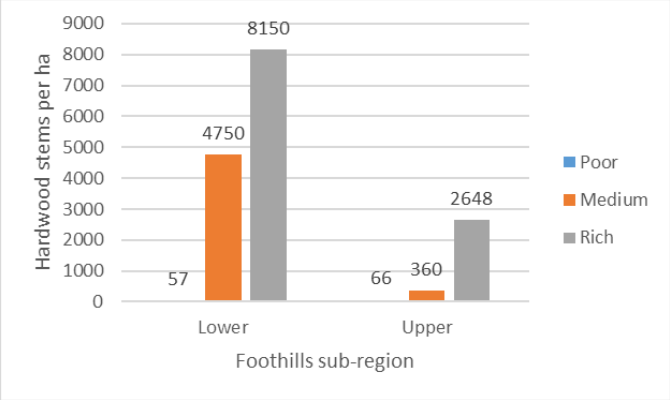

Figure 3. Average hardwood density in control plots by natural sub-region and soil nutrient regime.

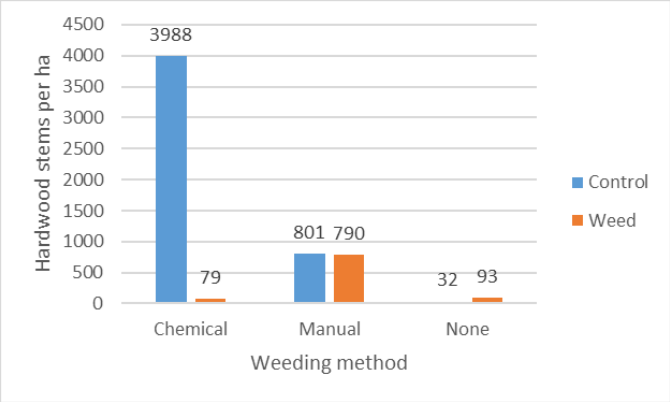

Figure 4. Effect of weeding method on hardwood density.

Figure 4 illustrates the effect of weeding on hardwood densities at 18 years, comparing control (i.e. untended) plots with those designated for weeding. Results are shown averaged across the entire trial by weeding method. Where chemical treatment was considered unnecessary on plots designated for weeding, and tending was either manual or not at all, little hardwood competition is evident in either the control or weeded plots. (We found no statistical difference in hardwood densities between control and weeded plots where the weeding method was either “manual” or “none”.) In installations where chemical weeding was undertaken, the difference in hardwood densities between control and weeded plots is high in both magnitude and statistical significance.

Conclusions

High hardwood densities severely constraining lodgepole pine growth and yield are most likely to occur on rich soil nutrient regimes in the Lower Foothills, but can also occur on medium sites in the Lower Foothills and rich sites in the Upper Foothills. On such sites failure to undertake chemical weeding during the establishment of lodgepole pine will on average reduce merchantable pine MAI by at least 50%, and at high levels of competition the reduction may be 100%. Chemical weeding is efficacious in controlling hardwoods; but manual weeding is ineffective even at low hardwood densities.

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.