

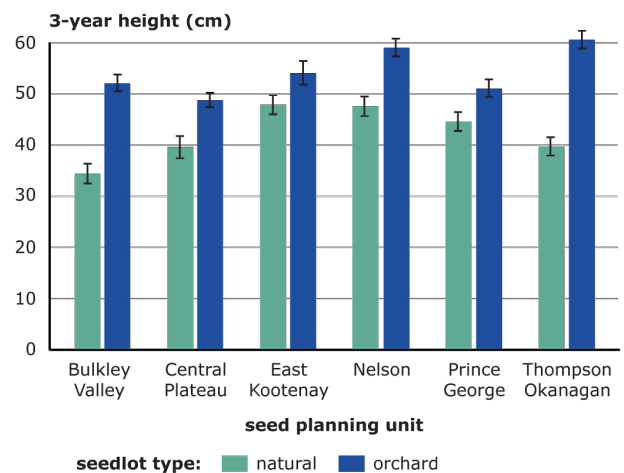
## Lodgepole pine class A vs B seed; early growth and cold hardiness

A 3-year-old common-garden trial of lodgepole pine (Pli) seedlings showed substantially increased growth rates for orchard seed (class A) compared to wild seed (class B or B+) with no apparent differences in fall cold hardiness. This work was implemented by PhD student Ian MacLachlan as a part of the UBC AdapTree project to evaluate the effects of selective breeding on growth and climatic adaptation. The threat of tree maladaptation due to climate change has increased interest in the differences among seed sources in climate-related adaptive traits, and in how selective breeding might change those traits. The AdapTree project builds on a long record of FLNRO field-based provenance research to better understand these differences at both the level of tree response (phenotypic) and in the underlying DNA.

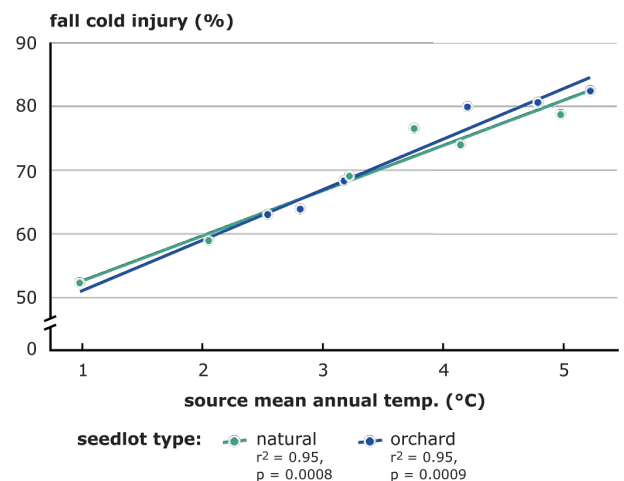
For this trial, lodgepole pine common gardens trials were established on the UBC campus in Vancouver for short-term high-intensity phenotypic data collection, and at the UBC Alex Fraser Research Forest near Horsefly. Each trial contained ~1300 seedlings grown from both orchard and wild-stand seed representing six seed planning units (SPU) across the species' range in BC. Data for a large number of growth and phenology traits, including height, growth rate, shoot dry mass, bud break, bud set, growing period duration, and fall cold injury were collected.

Results from the UBC trial show a strong response in all growth traits to selective breeding. Height growth increases of up to 50% (Figure A) and shoot dry mass increases of >100% over wild stand seedlings were found. Bud break shows small and inconsistent differences between orchard and wild seed, while summer bud set is delayed from three to eleven days, across the six SPUs. Fall cold injury assessed in artificial freeze tests at -16°C, expressed as a regression of injury on the mean annual temperature (MAT) of the seed source, shows no significant change due to breeding (Figure B). This result is expected, as genetic selections for Pli done in long-term field trials has focused on growth and tree health. Health is an aggregation of cold hardiness and a tree's ability to withstand a variety of pest and environmental factors (cold, snow, etc.). As a result, selected tree populations used in seed orchards are the fastest growing trees that are also able to thrive in the rigors of the field-test environment.

Climatic clines in growth traits are most strongly associated with temperature-related variables. Class A seedlings show steeper clines with MAT than class B and B+ seedlings, indicating that the strength of local adaptation for this trait increases as a result of selective breeding. Clines in MAT for cold injury (Figure B) are strong in both wild and selected seed



**Figure A.** Three-year height by seed planning unit for natural stand and orchard seed sources for six seed planning units.



**Figure B.** Fall cold injury relative to seed source mean annual temperature for natural stand and orchard lots from six SPU.



lots, but there is no statistically significant impact on MAT clines for cold injury due to selective breeding.

This project shows that selective breeding increases the growth rate of lodgepole pine seedlings, supporting the use of Class A seed lots for reforestation and the rapid attainment of 'free to grow' status. Seedlings from orchard seed appear to have equivalent levels of fall cold hardiness as wild seed from the same source populations

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