Genetic parameters of growth and adaptive traits for aspen (*Populus tremuloides*): implications for tree breeding under climate change.

Chen Ding[1]*, Andreas Hamann[1], Rong-Cai Yang[2] & Jean S. Brouard[3]

Unpublished manuscript available upon request.

[1] Department of Renewable Resources, University of Alberta, 751 General Services Building, Edmonton, AB, Canada, T6G 2H1

[2] Department of Agricultural, Food & Nutritional Science, University of Alberta, 1424 College Plaza, Edmonton, AB, Canada, T6G 2C8

[3] Isabella Point Forestry Ltd., 331 Roland Road, Salt Spring Island, BC, Canada, V8K 1V1

* Corresponding author's contact information:
Tel: (780) 492-2540
Fax: (780) 492-4323
Email: cd2@ualberta.ca

Running head: Aspen ecological and quantitative genetics

Keywords: Ecological genetics, phenology, growth, heritability, genetic correlations

Paper type: Original paper

Manuscript length: Abstract - 309 words; main text - 4841 words; 3 tables; 5 figures

Abstract

Aspen is a widespread commercial forest tree of high economic importance in western Canada and has been subject to tree improvement efforts over the past two decades to increase productivity of the forested land base. Successful selection and breeding programs rely on both accurate estimate of the potential for genetic gain for commercial traits as well as correlated responses of other traits that may be important for fitness. Here, we estimate genetic parameters of growth and adaptive traits in 10 progeny trials containing more than 30,000 trees with known pedigree structure, including 60 half-sib families, 100 full-sib families and 1,400 clones. Narrow-sense as well as broad sense heritabilities were generally low with values around 0.2 and standard errors of approximately 0.1. Phenology traits, bud break and leaf abscission, had moderate broad- and narrow-sense heritabilities around 0.4 with standard errors of 0.1. For all measured traits, additive genetic variation was most important and dominance and epistatic variance components were small or zero. Moderate to strong genetic correlations were found between growth and phenology (r=-0.3 and 0.7) with tall trees being associated with early budbreak and late leaf abscission. Survival was not compromised by early bud break or late leaf abscission. In fact, the reverse appeared to be true, indicating that utilization of the growing season was more important than avoidance of early fall frosts or late spring frosts across all test sites in this experiment. We conclude that selection for growth traits in five to eight year old aspen trees promises only small genetic gains, but higher heritabilities are expected at a later date based on other trials. Strong additive genetic correlations between growth and phenology indicates that much of the genetic gain at the early stage of stand development will be due to expanding the growing season, which may increase the risk of frost damage in spring and fall.