Project Purpose and Management Implications:
Drought-induced seedling mortality of planted Douglas-fir is currently a major problem in the Sub-maritime Zone, and this situation may worsen as climates change. The purpose of this project is to quantify the water use efficiency of 45 families of sub-maritime Douglas-fir from first-generation seed orchards planted in progeny tests, and to test the drought tolerance of a subset of these families. Knowing the range of drought tolerance in progeny from seed orchards producing seed for the sub-maritime zone allows breeders to select parents which will produce drought-tolerant progeny. Results from this work will have direct application to Douglas-fir family selection in the BCMoFR Forest Genetics Program, allowing breeders to select families which will continue to perform well in the face of decreasing annual rainfall.

Project Length:
The project began in September 2007 when the MSc student began her studies and began to plan the project. Funding was obtained from FIA-FSP from April 1, 2008 to March 31, 2009. The student will defend her thesis and submit journal publications from the work by the end of August, 2009.

Methodology Overview:
Douglas-fir seedlings from 93 seed orchard families, 5 top-cross families and 5 open-pollinated controls were planted in progeny tests in three locations near Blackwater, Birkenhead and Hurley in 2005. In December 2007, current-year shoots from 5 trees from each family were collected for assessments of cold hardiness and stable carbon (C) isotopes. Stable C isotope analysis of woody tissue provides an integrated measure of plant water stress over the growing season and can reveal family differences in long-term water use efficiency. This preliminary analysis allowed us to select 40 families with a range of C isotope ratios for further analysis. Cold hardiness was also assessed in March, 2008.

In October 2008, current-year shoots were collected from three trees/family/progeny test site for 5 top-cross families and 40 seed orchard families with a range of growth rates and stable C isotope ratios. The sampled trees were also measured for root collar diameter, height and current-year height increment. On the driest of the three sites, some measurements of pre-dawn shoot water potential were made in July and September 2008. Shoot water potentials were very high due to an unusually wet summer, thus we had little success in correlating shoot water potential measurements with C isotope discrimination.

A complimentary pot trial at the UVic field planting site tested seedlings from 22 selected seed orchard families in 3 drought treatments. Seedlings were protected from natural rainfall and were watered to field capacity before the drought treatments began.

Needle transpiration and assimilation rates were measured on 2 seedlings/family/drought treatment/block in August and September. Shoot water potential was assessed on the same seedlings on these dates. In October, seedlings were harvested and assessed for biomass
allocation and root morphology. Date of bud burst, mid-summer chlorophyll fluorescence and survival were also assessed.

**Project Scope and Regional Applicability:**
Seedling mortality of planted Douglas-fir in the Sub-maritime Zone is currently a problem, and drought is a major contributor to this mortality. This situation is expected to worsen as climates change. There is, therefore, a critical need to know the range of drought tolerance in progeny from seed orchards producing seed for this zone.

The scope of this project is to explore the range of drought tolerance in families of sub-maritime Douglas-fir from first-generation seed orchards. It is applicable to the sub-maritime transition zone in southern BC. Results will be directly applied in the Douglas-fir breeding program led by the Forest Genetics Section, Research Branch, BC MOFR.

**Interim Results:**

**Pot Trial:**
Family (Female parent) had a significant effect (p-value < 0.05) on: root biomass, shoot biomass, root / shoot ratio, height, growth, stomatal conductance, transpiration rate and net photosynthetic rate.
Drought treatment had a significant effect (p-value < 0.05) on: root biomass, shoot biomass, root / shoot ratio, shoot water potential, chlorophyll fluorescence, and gas exchange.
Chlorophyll fluorescence was negatively correlated with family mortality.
Leaf biomass was negatively correlated with gas exchange.
Root/shoot ration was positively correlated with gas exchange.

**Field Trial:**
Family (Female parent) had a significant effect (p-value < 0.05) on: fall cold hardiness.
Test site had a significant effect (p-value < 0.05) on: height and leader growth, root collar diameter, C isotope fractionation and fall cold hardiness.
Height and survival were negatively correlated.
Height and spring cold hardiness were negatively correlated.
Leader growth and shoot water potential were positively correlated.

Data analysis is on-going. Heritability of various traits are being calculated. Conclusions will be finalized by August, 2009.

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