Inter-varietal Hybrid Douglas-Fir

Growth Potential of Coastal Sources and Winter Hardiness of Interior Sources

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Key Management Point:

• Hybrid Douglas-fir is outperforming interior and coastal parent sources in Northern Idaho.
Outline

• Background on Hybrid Douglas-fir

• Overview of published research

• Current work
## Douglas-Fir Varieties

<table>
<thead>
<tr>
<th></th>
<th>Coastal</th>
<th>Interior</th>
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</thead>
<tbody>
<tr>
<td>Growth</td>
<td></td>
<td>✔️</td>
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<tr>
<td><em>Rhabdocline pseudotsugae</em> Tolerance</td>
<td>✔️</td>
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<tr>
<td>Cold Hardiness</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Drought Hardiness</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Shade Tolerance(^a)</td>
<td>✔️</td>
<td>✔️</td>
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</tbody>
</table>

- Coastal Douglas-fir: Second tallest Conifer
- Interior Douglas-fir: - 40 °C
- Varieties are completely interfertile
Genetic Structure of Douglas-Fir
Genetic Structure of Douglas-Fir

Ecology and Evolution

Intervarietal and intravarietal genetic structure in Douglas-fir: nuclear SSRs bring novel insights into past population demographic processes, phylogeography, and intervarietal hybridization

Marcela van Loo¹, Wolfgang Hintsteiner¹,², Elisabeth Pötzensberger¹, Silvio Schüle³ & Hubert Hasenauer¹
Genetic Structure of Douglas-Fir

- Clinal Variation in Growth Potential

Comparative genetic responses to climate in the varieties of *Pinus ponderosa* and *Pseudotsuga menziesii*: Clines in growth potential

Gerald E. Rehfeldt, Laura P. Leites, J. Bradley St Clair, Barry C. Jaquish, Cuauhtémoc Sáenz-Romero, Javier López-Upton, Dennis G. Joyce
Management opportunities:
• Increased climatic resilience
• Increased productivity

“...Thus it seems likely that planting stock combining specific site adaptation and rapid growth can be produced by racial crossing.

– Duffield, 1950
Growth and Cold Hardiness Testing of Inter-varietal Hybrid Douglas-fir

- **Coastal Douglas-fir**
  - 15 Paternal half-sib families

- **Interior Douglas-fir**
  - 18 Maternal half-sib families
Hybrid Douglas-fir Test Results

• Planted as seed in 1971

• 70 full-sib hybrid families

• 33 half-sib families from parental lines
Hybrid Douglas-fir Test Results

- Winter drought in 1972
  - as low as -26 °C
  - Interior: 44% Survival
  - Hybrid: 44% Survival
  - Coastal: 9% Survival

- Traits
  - Specific Combining effects
  - Weak additive for Growth Potential
  - Intermediate for other adaptive traits
4-Year Old Seedling Performance at Coeur d' Alene and Priest River Experimental Forest Nurseries

Rehfeldt, 1977
Cold Hardiness Development Through Fall

Rehfeldt, 1977
Green Creek Field Test

Elevation : 3400 feet
Latitude: 46 degrees
Longitude:116  degrees

• 3 year-old (1-2) stock planted in 1975

• 70 full-sib hybrid families

• Fewer than 33 half-sib families from parental lines
10 year field trial:
- Hybrid survival = interior parents
- Hybrid height was \( \sim 2 \times \) height of interior parents
Naturalization in Europe

- Douglas-fir introduced/naturalized in > 30 European countries
- Intraspecific genetic admixture contributes significantly to the invasive success of non-native species
- Increased pool of raw material for adaptive evolution

(by T. Eckhart)
(Spiecker et al., 2019)
Douglas-fir Breeding in Saxony

By H. Braun

Saxon State Institute for Forestry, D-01827 Grunpa, Germany

(Received 24th April 1986)

Summary

Due to its high productivity as well as good ecological and silvicultural characteristics, Douglas-fir plays a special role among the introduced species in Germany. A decisive factor in successful stand establishment is the genetic suitability of the plants for the specific plantation site. Therefore, in Grunpa the investigations done were focused on provenance research as well as on studies of locally selected stands and on the supply

2. Progeny Testing of Native Stands and Using the Results

In 1981 and 1982, 21 Douglas-fir stands were selected in cooperation with the local forest service. The selected stands as well as the subsequent progeny trials and the two seedlings seed orchards are located on the map in figure 1.

Fig. 8 – Location of the trial plots.
Fig. 10. – Progeny test of Douglas fir hybrids, age 1/1, nursery results (frost resistance – 9 – no damage).

Braun, 1998
**Fig. 7.** Progeny test of Douglas fir hybrids. Height growth at age 16 after planting.
Hybrid forward selection(s) in the BC Ministry breeding orchard at Kalamalka.
Growing a Better Douglas-Fir

These Douglas-Fir trees were planted in 1975 when they were two years old. The tallest trees are special hybrids made from crossing a cold-hardy North Idaho variety with a fast-growing Pacific coast variety. The shorter trees are pure North Idaho trees. Pure coastal trees were also planted but died from cold temperatures.
Green Creek Field Test
44 years after planting

Excellent growth and survival of the Hybrid families was obvious.

“Realization of the tremendous potential of hybridization for improvement of the interior variety will require at least one backcross generation or additional crosses utilizing introgressed populations.” – Rehfeldt, 1977
Green Creek Field Test
44 years after planting

- Remonument
- DBH
- Survival
- Growth Increment
- Spatial Data
Surv = 29%  
n = 87

Surv = 50%  
n = 587

Surv = 13%  
n = 43

Surv = 29%  
n = 87

Preliminary results based on ¾ of test measured, does not consider density dependent competition
Hybrid Douglas-fir
Moscow Forest Sciences Laboratory
Moscow, Idaho

Planted: ~ 1975
Hybrid Douglas-fir
Moscow Forest Sciences Laboratory
Moscow, Idaho

Planted: ~ 1975
DBH: 23.1 inches
PREF Clonal Orchard

- Planted in 1996 using best performing crosses and parent clones at Green Creek
- Assess Trait Segregation
- Assessing Backcross Performance
- Hybrid Breakdown
IETIC working with NWTIC (Northwest Tree Improvement Coop) to cross top performers from the inland and the coast

• Medford OR orchard will be used to create hybrid crosses this spring.

Potential Production Approaches:
- Top Grafting?
- Controlled Mass Pollination?
- Micropropagation via somatic embryogenesis?

Photo by: Nathan Hanzelka
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