

# The New Zealand Douglas-fir Breeding Program: Proposed Adjustments for a Changing Climate

Heidi Dungey,<sup>1</sup> Charlie Low,<sup>1</sup> Mark Miller,<sup>1</sup> Kane Fleet,<sup>1</sup> and Alvin D. Yanchuk<sup>1</sup>

## Abstract

Genetic improvement of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) in New Zealand was initiated in 1955 with large provenance trials established in the late 1950s. These trials showed that material of Oregon and Californian origin was growing faster than other provenances. Additional collections were made to further evaluate provenance performance from these two areas, and in 1996 additional trials were established at four low-altitude sites across New Zealand.

Genotype × environment (G×E) interaction between these sites was found to be important for diameter at breast height (DBH), less important for stem straightness and malformation, and not important for outerwood acoustic velocity (a surrogate for wood stiffness). Heritabilities were low to moderate for all growth traits, and very low for malformation. Heritability for Swiss needle cast caused by *Phaeocryptopus gaeumannii*, measured as needle retention, was moderate at one site (0.37) with a high infection rate, and was likely a major factor creating G×E interactions for growth among sites. The heritability of wood acoustic velocity was moderate to high at individual sites (0.26 to 0.74) and across sites (0.49). Individual-trait selection revealed the potential for good genetic gains to be made when selecting the top 20 families for diameter growth (an average of 10.7 percent), straightness (an average of 11.5 percent), and acoustic velocity (an average of 7.0 percent).

When we examined how gains were distributed when selecting for needle retention and/or DBH, we found that selecting for needle cast at the affected site did not compromise DBH gains at that site. Selecting for genotypes with low needle cast at the affected site did, however, effect gains for DBH estimated across all sites and would not be an ideal scenario. In order to maximize gains across the current Douglas-fir growing estate, a division of growing sites between those affected by needle cast and those not affected would seem sensible, particularly given recent work into climate change scenarios indicating that Swiss needle cast will become more important in the South Island and even more destructive in the North Island of New Zealand. We therefore suggest addressing differences in site through the development of separate deployment populations.

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<sup>1</sup> Scion, Te Papa Tipu Innovation Park, 49 Sala Street, Private Bag 3020, Rotorua, 3046, New Zealand.  
Corresponding author: Heidi.Dungey@scionresearch.com.