From Forest Nursery Notes, Winter 2009

**172. © Morphological and physiological variation in western redcedar (*Thuja plicata*) populations under contrasting soil water conditions.** Fan, S., Grossnickle, S. C., and Russell, J. H. Trees 22:671-683. 2008.

Trees (2008) 22:671–683
DOI 10.1007/s00468-008-0225-8



ORIGINAL PAPER

# Morphological and physiological variation in western redcedar (*Thuja plicata*) populations under contrasting soil water conditions

**Shihe Fan · Steven C. Grossnickle · John H. Russell**

Received: 26 October 2007 / Revised: 26 February 2008 / Accepted: 27 March 2008 / Published online: 15 April 2008


**Abstract** Adaptation to precipitation conditions may induce genetic diversity that changes morphological and physiological traits. This hypothesis was investigated in the seedlings of seven western redcedar (*Thuja plicata* Donn ex D. Don) populations, which were collected along a precipitation transect from the Pacific coast to the southern interior of British Columbia, Canada. The experimental seedlings were either well-watered or soil-droughted and measured for growth, gas exchange rates, transpiration efficiency, and carbon isotope discrimination during or at the end of the third growing season. Significant variation was found in most of these morphological and physiological traits among the populations. Much of this variation occurred under well-watered, but not so much under droughted conditions. Mean height increments and transpiration efficiency showed a significant linear relationship, but biomass increments exhibited a quadratic relationship with precipitation on the origin site of these populations. Measurements of water use efficiency obtained from instantaneous gas exchange measurements, carbon isotope discrimination, and transpiration efficiency were intercorrelated in the seedlings. However, neither did any of these measurements consistently rank the populations, nor were they indicative of adaptation to climatic precipitation conditions in these western redcedar populations.

**Keywords** Carbon isotope discrimination · Gas exchange · Precipitation · Adaptation · Water use efficiency

Communicated by R. Guy.

S. Fan (✉)
Capital Health, Suite 300, 10216, 124 Street,
Edmonton, AB, Canada T5N 4A3
e-mail: shihe.fan@capitalhealth.ca

S. C. Grossnickle
CellFor Inc., #4 6772 Oldfield Road,
Saanichton, BC, Canada V8M 2A3

J. H. Russell
British Columbia Ministry of Forests, Research Branch,
Cowichan Lake Research Station, P.O. Box 335,
Mesachie Lake, BC, Canada V0R 2N0

## Introduction

Western redcedar (*Thuja plicata* Donn ex D. Don) is an economically important tree species of the Pacific Northwest forests of North America. Within this geographic area, it has two nonoverlapping ranges. On the Pacific coast, this species occurs from northern California to southeastern Alaska at sea level to over 1,000 m in elevation. In the interior, western redcedar grows from western Montana and northern Idaho of the United States to central British Columbia (BC) of Canada at elevations between 300 and 2,100 m (Minore 1990).

Although widely distributed under sharply contrasting environmental conditions, western redcedar has surprisingly showed very little genetic variation in isozymes (Copes 1981; Yeh 1988; El-Kassaby et al. 1994), terpenes (Van Rudloff and Lapp 1979; Van Rudloff et al. 1988), or even growth (Bower and Dunsworth 1987). DNA analyses mirror these findings, detecting little genetic variability in populations of different geographic regions (Glaubitz et al. 2000). Other studies, however, have found significant quantitative genetic variation in physiological traits, e.g., winter hardiness (Rehfeldt 1994; Cherry 1995) and gas exchange response to atmospheric vapor pressure deficits (Grossnickle et al. 2005), in monoterpenes (Vourc'h et al.