From Forest Nursery Notes, Winter 2012

**219. © Critical water stress levels in *Pinus patula* seedlings and their relation to measures of seedling morphology.** Rolando, C. A., Pammenter, N. W., and Little, K. M. Southern Forests 73(1):41-49. 2011.

Southern Forests 2011, 73(1): 41–49
Printed in South Africa — All rights reserved


SOUTHERN FORESTS
ISSN 2070–2620 EISSN 2070–2639
doi: 10.2989/20702620.2011.576481

# Critical water stress levels in *Pinus patula* seedlings and their relation to measures of seedling morphology

**CA Rolando[1]*, NW Pammenter[2] and KM Little[3]**

[1] *Scion, PO Box 3020, Rotorua 3046, New Zealand*
[2] *School of Biological and Conservation Sciences, South Ring Road, Westville Campus, University of KwaZulu-Natal, Private Bag X54001, Durban 4000, South Africa*
[3] *Institute for Commercial Forestry Research, PO Box 100281, Scottsville 3209, South Africa*
* *Corresponding author, e-mail: carol.rolando@scionresearch.com*

A pot trial was implemented to determine the effect of soil water stress following transplanting on shoot water potential and stomatal conductance of *Pinus patula* seedlings. The relationship of seedling morphology to measures of water stress was also investigated. The trial consisted of two watering treatments: a control (no water stress) and a severe water stress (no further water after planting). The treatments were applied to recently transplanted seedlings selected to reflect a range of sizes typical in an operational environment. Measures of shoot water potential and stomatal conductance, root and shoot growth and environmental variables were made. The results indicated that *P. patula* seedlings tolerated high air and soil temperatures (above 35 °C) and low soil water availability (−1.5 MPa). The water potential threshold for changes in stomatal conductance was in the region of −0.8 to −0.9 MPa and stomatal closure had occurred at a shoot water potential of between −1.8 and −2.1 MPa. Mortality occurred when shoot water potential declined to below −3.0 MPa. There was variability between seedlings in their potential for survival and growth. Inherently bigger seedlings had a greater capacity for new root growth following planting. Mass of new roots was significantly and positively related to higher rates of transpiration under conditions of low soil moisture.

**Keywords:** growth, mortality root mass, *Pinus patula*, seedling quality, soil water stress

## Introduction

*Pinus patula* Scheide ex Schlect. and Cham. is the most widely planted softwood species in plantation forestry in the summer rainfall region of South Africa (DWAF 2005). Unacceptable mortality of this species following planting is a concern and has the potential to affect its future deployment for commercial timber. Applied research carried out to understand the impact of silvicultural and site management factors has indicated heat stress, pests and diseases and the management of harvest residues as affecting mortality (Morris 1990, Bayley and Kietska 1997, Allan and Higgs 2000, Allan et al. 2000, Crous 2005, Rolando and Little 2005). Although this research has helped improve silvicultural practices, there is still an inadequate understanding of the direct causes of mortality and the effects of non-optimal environmental conditions on *P. patula* seedling physiology and growth immediately after planting. This is coupled with a general lack of studies, both locally and internationally, investigating the morphological and physiological characteristics of *P. patula* seedlings (Rundel and Yoder 1998, Oviedo and Emmingham 2003). Understanding how this species responds to different environmental stresses may provide an indication of the type of stock required to meet the demands of the site, as well as increase our understanding of the effects of early silviculture on mortality.

In the forest industry, quality seedlings are those that will meet a desired level of survival and growth following planting (South and Mexal 1984, Mohammed 1997). In South Africa *P. patula* seedlings are raised in container nurseries with production continuing throughout most of the year. A variety of containers, ranging between 36 $cm^3$ and 80 $cm^3$ in cavity volume, and 49 and 128 cavities per tray, are used (Zwolinski and Bayley 2001). Seedlings are generally small at the time of planting (<30 cm height and 2 mm in stem diameter), possessing mostly primary needles. Besides one published study (South and Mitchell 2006), research to identify the optimum 'plant quality window' for different container types is generally lacking, and this, together with a lack of a quality grading system, means that seedlings of poor quality and small size may often be used for establishment. The general consensus amongst foresters and nursery managers is that smaller seedlings survive better than larger seedlings (Zwolinski and Bayley 2001). This is frequently linked to root malformations of larger planting stock that has been left in small containers too long, a condition locally referred to as 'over-prime' or 'root bound' (Bayley and Kietzka 1997, Zwolinski and Bayley 2001, South and Mitchell 2006). A better understanding of the relationship between seedling quality and early survival is key to improving nursery standards as well as early survival and growth.