New Phytologist

Research

Identification of drought-sensitive beech ecotypes by physiological parameters 27.)

A. D. Peuke[1], C. Schraml[1], W. Hartung[2] and H. Rennenberg[1]

[1]Institut für Forstbotanik und Baumphysiologie, Professur für Baumphysiologie, Georges-Köhler-Allee Geb. 053/054, D–79110 Freiburg im Breisgau, Germany; [2]Julius-von-Sachs-Institut für Biowissenschaften, Julius-von-Sachs-Platz 2, D–97082 Würzburg, Germany

Author for correspondence:
A. D. Peuke
Tel: +49 761 203 8310
Fax: +49 761 203 8302
Email: ad_peuke@web.de

Received: *13 December 2001*
Accepted: *2 January 2002*

Summary

• The effects of drought on European beech (*Fagus sylvatica*) were assessed in a pot experiment under controlled conditions.

• Plants from 11 autochthonous provenances originating from regions in Germany, which differed in annual precipitation, were exposed to a 3-wk drought period in a glasshouse after the first stage of shoot growth had been completed.

• Drought reduced the water content to 97% of control in leaves and axes and to 92% in the roots. A strong reduction of predawn water potential in roots and shoots, as well as on transpiration rate, was found. In the roots, the effect on water potential was the same for all provenances, but differences were observed in the shoot water potential. Leaf concentrations of abscisic acid (ABA), proline and sucrose increased in the drought-treated plants compared with the controls.

• Two extreme clusters from opposite climatic sites were identified by cluster analysis. A drought-sensitive cluster, originating from regions with high annual precipitation, had low water potential and transpiration rates, as well as high concentrations of fructose, ABA and proline after drought. Water potential and transpiration rates were less affected by drought in the other cluster, which comprised two provenances of relatively dry habitats, and concentrations of hexose, ABA and proline were low.

Key words: beech (*Fagus sylvatica*), provenances, drought stress, water potential, transpiration, osmoprotectants, abscisic acid.

Introduction

Global environmental conditions have changed rapidly over the last century as a result of human activities. One of these changes is the increase of atmospheric CO_2 by fossil fuel combustion, deforestation and biomass burning contributing to the glasshouse effect (Enquete-Komission, 1994; Saxe *et al.*, 1998; UNEP/IUC, 1999). Based on current trends, it is expected that within this century CO_2 concentrations will double and global temperature will rise by about 1–3.5°C (UNEP/IUC, 1999). As a consequence, precipitation and evaporation patterns will change and forests and other ecosystems will be exposed to drought and flooding events.

The increased frequency and severity of drought caused by climatic changes will affect plants directly through water depletion and indirectly by reduced nutrient uptake (Saxe *et al.*, 1998). Plants in a CO_2-enriched climate of the future might tolerate drought better through stomatal closure and/or decline in stomatal density (Bowes, 1993), but elevated CO_2 may also increase leaf area and thereby counteract the favourable effects of reduced stomatal aperture/density under water limitation (Saxe *et al.*, 1998).

For long-living plants, such as forest trees, the expected climatic changes will become relevant within the lifespan of an individual within the community. European beech (*Fagus sylvatica*) is one of the most important forest trees in central Europe and is known to be relatively drought sensitive (Ellenberg, 1992). Beech forests have mainly developed by natural regeneration and ecotypes have developed that are adapted to the local climatic conditions (Müller-Stark, 1997).