



Research paper

Impacts of drought on mineral macro- and microelements in provenances of beech (*Fagus sylvatica* L.) seedlings

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Beech seedlings originating from 11 German provenances with different climatic conditions were grown in pots and cultivated in a greenhouse. The composition of macro- and microelements in roots, axes and leaves was measured after half of the seedlings were subjected to a simulated summer drought. The recently described sensitivity of these provenances to drought was compared with drought-mediated changes in the elemental and ionic composition in organs of the seedlings; in addition, partitioning between roots and shoots was evaluated. A number of element concentrations were decreased in roots due to drought (K 94% of control, Mg 94%, Mn 75% and Zn 85%). However, chloride concentration increased in all organs (115–125%) and was the only element affected in leaves. Some changes in ionome can be related to sensitivity of provenances, but it is difficult to decide whether these changes are a result of, or a reason for, drought tolerance or sensitivity. Observed increases in chloride concentration in all plant parts of drought-treated beech seedlings can be explained by its function in charge balance, in particular since the level of phosphate was reduced. As a result of chloride accumulation, the sum of added charges of anions (and cations) in water extracts of leaf and root material was similar between drought and control plants. Since only the partitioning of Ca and Al (both only in axis) as well as Mn was affected and other elements (together with previously observed effects on C, N, S and P) remained unaffected by drought in all provenances, it can be concluded that direct effects by means of mass flow inhibition in xylem and phloem are unlikely. Secondary effects, for example on the pH of transport sap and the apoplastic space, cannot be excluded from the present study. These effects may affect partitioning between the apoplast and symplast and therefore may be significant for drought sensitivity.

Keywords: anions, beech, cations, plant nutrition, water stress.

Introduction

European beech (*Fagus sylvatica* L.) is one of the dominant tree species in Central Europe that is known to be drought sensitive (Backes and Leuschner 2000, Gessler et al. 2004). Climate models predict an increase in air temperature and changing precipitation patterns, which in combination can increase the risk of severe drought periods in the current range of distribution of beech (IPCC 2007). During the 2003 summer drought, beech forests in Central Europe were among those forests that expressed the largest reductions in net ecosystem productivity (Ciais et al. 2005). Drought affects tree function in many ways, including gas exchange, cell growth

and division, phytohormone levels, metabolism and transport processes (Hsiao 1973). Owing to drought, gradually decreasing stomatal conductance, predawn leaf water potential, assimilation and growth are commonly observed in trees, accompanied by a stimulation of fine root growth (Leuzinger et al. 2005). In addition, both greater temperatures and periods with limited water supply are thought to alter the ability of terrestrial ecosystems to take up elements. Leaves, roots and stems generally differ in their sensitivity to drought. Therefore, a whole-tree approach rather than restricted studies at the leaf level is required to properly address the consequences of drought on tree function (Leuschner et al. 2001).