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RESEARCH PAPER

Competition for nitrogen sources between European beech (*Fagus sylvatica*) and sycamore maple (*Acer pseudoplatanus*) seedlings

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Keywords

^{15}N uptake; *Acer pseudoplatanus;* amino acids; ammonium; *Fagus sylvatica;* N compounds; nitrate; soluble protein.

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ABSTRACT

To investigate the short-term consequences of direct competition between beech and sycamore maple on root N uptake and N composition, mycorrhizal seedlings of both tree species were incubated for 4 days (*i.e.* beech only, sycamore maple only or both together) in an artificial nutrient solution with low N availability. On the fourth day, N uptake experiments were conducted to study the effects of competition on inorganic and organic N uptake. For this purpose, multiple N sources were applied with a single label. Furthermore, fine roots were sampled and analysed for total amino acids, soluble protein, total nitrogen, nitrate and ammonium content. Our results clearly show that both tree species were able to use inorganic and organic N sources. Uptake of inorganic and organic N by beech roots was negatively affected in the presence of the competing tree species. In contrast, the presence of beech stimulated inorganic N uptake by sycamore maple roots. Both the negative effect of sycamore maple on N uptake of beech and the positive effect of beech on N uptake of sycamore maple led to an increase in root soluble protein in beech, despite an overall decrease in total N concentration. Thus, beech compensated for the negative effects of the tree competitor on N uptake by incorporating less N into structural N components, but otherwise exhibited the same strategy as the competitor, namely, enhancing soluble protein levels in roots when grown under competition. It is speculated that enhanced enzyme activities of so far unknown nature are required in beech as a defence response to inter-specific competition.

INTRODUCTION

During the past decades, forest management practices have changed in Central Europe from supporting conifer monocultures to supporting mixed species stands, promoting the natural regeneration of deciduous tree species (*e.g.* Tarp *et al.* 2000; Fotelli *et al.* 2001; Petritan *et al.* 2009). In this context, European beech (*Fagus sylvatica* L.), the dominant tree species of the potential natural vegetation in moist to moderately dry areas of the sub-mountainous altitude range in Central Europe (Ellenberg 1996), is favoured by forest practitioners and governments (*e.g.* Fotelli *et al.* 2001; Gessler *et al.* 2007). However, as a tree species that does not appear to be tolerant to strong and prolonged periods of drought (Backes & Leuschner 2000; Rennenberg *et al.* 2004; Gessler *et al.* 2007), the predicted change in climate, *i.e.* elevated temperature, enhanced frequency and duration of summer droughts ((IPCC) 2007), could have negative effects on its physiological performance and growth (*e.g.* Peuke *et al.* 2002; Fotelli *et al.* 2003; Gessler *et al.* 2007). Apparently, these climate changes most likely reduce the competitiveness of beech in currently beech-dominated forests (Backes & Leuschner 2000; Rennenberg *et al.* 2004; Gessler *et al.* 2007) and may constitute a competitive advantage for other tree species, especially at the juvenile stage where plants are typically highly vulnerable to limiting water availability (Grime & Hunt 1975; de Jong 1995; Madsen & Larsen 1997; Fotelli *et al.* 2002).

The uptake of nutrients from the soil – particularly of growth-limiting nitrogen – and their partitioning inside the plant are both directly dependent on sufficient water supply. Thus, a decrease in soil water availability leads to a reduction in mineral nutrient uptake and thereby mediates an indirect negative effect on the performance of beech (Rennenberg *et al.* 2004). Furthermore, tree growth and development is limited by nitrogen availability in numerous forest ecosystems not exposed to considerable amounts of anthropogenic nitrogen (Rennenberg *et al.* 1998; Lovett *et al.* 2004; Chapman *et al.* 2006). Therefore, under limiting N conditions, competition for N will increase at reduced water supply, not only between vegetation and soil microorganisms, but also between beech and other components of the vegetation (Fotelli *et al.* 2002, 2005).

Most studies investigating the interference of other vegetation components with trees focus on annual or perennial plants (*e.g.* Woods *et al.* 1992; Clinton & Mead 1994a,b; Fotelli *et al.* 2002, 2005). Observations on competition