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82. © Nutrient and water availability alter belowground patterns of biomass allocation, carbon partitioning, and ectomycorrhizal abundance in *Betula nigra*.
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ORIGINAL PAPER

Nutrient and water availability alter belowground patterns of biomass allocation, carbon partitioning, and ectomycorrhizal abundance in *Betula nigra*

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Abstract In managed settings, seedlings are often fertilized with the objective of enhancing establishment, growth, and survival. However, responses of seedlings to fertilization can increase their susceptibility to abiotic stresses such as drought. Seedlings acclimate to variation in soil resources by reallocating carbon among different physiological processes and compartments, such as above versus belowground growth, secondary metabolism, and support of ectomycorrhizal fungi (EMF). We examined the effects of nutrient and water availability on carbon allocation to above and belowground growth of river birch (*Betula nigra*), as well as partitioning among root sugars, starch, phenolics, lignin, and EMF abundance. As nutrient availability increased, total plant biomass and total leaf area increased, while percent root biomass decreased. Root sugars, total root phenolics and EMF abundance responded quadratically to nutrient availability, being lowest at intermediate fertility levels. Decreased water availability reduced total leaf area and root phenolics relative to well-watered controls. No interactions between nutrient and water availability treatments were detected, which may have been due to the moderate degree of drought stress imposed in the low water treatment. Our results indicate that nutrient and water availability significantly alter patterns of carbon allocation and partitioning in roots of *Betula nigra* seedlings. The potential effects of these responses on stress tolerance are discussed.

Keywords Optimal allocation theory · Growth-differentiation balance hypothesis · Acclimation · Phenotypic plasticity · Root:shoot ratio · Secondary metabolism · Stress tolerance · Water stress

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Introduction

Fertilization is routinely used to enhance establishment and growth of seedlings in managed settings. Although seedlings can benefit from fertilization in extremely nutrient-deficient soils where growth and photosynthesis may be severely constrained, over-fertilization in managed settings is common (Rytter et al. 2003) and can increase susceptibility to herbivores (Raupp et al. 2010), pathogens (Blodgett et al. 2005; Hagan et al. 2008; Piri 1998), and drought-related injury (Linder et al. 1987; Lloyd et al. 2006). Drought stress reduces seedling growth and establishment and can predispose seedlings to disease (Wargo 1996) and insect attack (Huberty and Denno 2004). Excessive fertilization may influence seedling physiology in ways that exacerbate drought-related injury (Kleczewski et al. 2010). Specifically, fertilization can alter patterns of seedling (1) biomass allocation; (2) concentrations/contents of carbon reserves and defense-related compounds; and (3) associations with mycorrhizal fungi (Kleczewski et al. 2010).