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ORIGINAL PAPER

Effect of controlled inoculation with specific mycorrhizal fungi from the urban environment on growth and physiology of containerized shade tree species growing under different water regimes

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Abstract The aim of this work was to evaluate the effects of selected mycorrhiza obtained in the urban environment on growth, leaf gas exchange, and drought tolerance of containerized plants growing in the nursery. Two-year-old uniform *Acer campestre* L., *Tilia cordata* Mill., and *Quercus robur* L. were inoculated with a mixture of infected roots and mycelium of selected arbuscular (maple, linden) and/or ectomycorrhiza (linden, oak) fungi and grown in well-watered or water shortage conditions. Plant biomass and leaf area were measured 1 and 2 years after inoculation. Leaf gas exchange, chlorophyll fluorescence, and water relations were measured during the first and second growing seasons after inoculation. Our data suggest that the mycelium-based inoculum used in this experiment was able to colonize the roots of the tree species growing in the nursery. Plant biomass was affected by water shortage, but not by inoculation. Leaf area was affected by water regime and, in oak and linden, by inoculation. Leaf gas exchange was affected by inoculation and water stress. V_{cmax} and J_{max} were increased by inoculation and decreased by water shortage in all species. F_v/F_m was also generally higher in inoculated plants than in control. Changes in PSII photochemistry and photosynthesis may be related to the capacity of inoculated plants to maintain less negative leaf water potential under drought conditions. The overall data suggest that inoculated plants were better able to maintain physiological activity during water stress in comparison to non-inoculated plants.

Keywords *Acer campestre* · Leaf gas exchange · OJIP test · PSII photochemistry · *Tilia cordata* · *Quercus robur* · Water stress

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Introduction

Mycorrhizal fungi are beneficial soil-inhabiting fungi that establish natural symbiotic associations with roots of native plants (Klingeman et al. 2002). Mycorrhizae affect the morphology of infected roots and induce changes to rhizosphere functioning (Kothari et al. 1990; Barea et al. 2002; Habte 2006), and they may play a role in enhancing plant tolerance to some natural and anthropogenic stressors, including water stress (Entry et al. 2002).

Perennial plants cope with water stress either by drought avoidance (maintaining high internal water potential at low external water potential) or by drought tolerance (survival at low internal water potential) or by both strategies (Levitt 1980). A series of studies, reviewed in Augé (2001), have demonstrated that mycorrhizae can increase tolerance to water stress in both drought-avoider and drought-tolerant species. Mechanisms proposed to explain the increased tolerance include greater root growth (Osonubi et al. 1992), increased soil water extraction (Graham and Syvertsen 1984), less negative water status during drought (Newman and Davies 1988), quicker recovery of water potentials after drought (Gemma et al. 1997), and higher osmotic adjustment

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