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Nursery fertilization affects seedling traits but not field performance in *Quercus suber* L.

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ABSTRACT

The success of forest plantations in areas subjected to seasonal drought is strongly dependent on seedling traits. However, there is no consensus on the set of plant traits determining establishment success in these environments. We hypothesize that traits associated with nutritional stress, such as reduced biomass allocation and changes in root morphology, may promote seedling resistance to drought. We tested this hypothesis by assessing the effect of different fertilizer types and doses on the morphology and field survival of *Q. suber* seedlings. This hypothesis had been previously tested with five Mediterranean species in a semi-arid environment. Nutrient deprivation decreased total biomass accumulation and slenderness ratio (ratio between stem height and root collar diameter). Nitrogen deprivation increased biomass allocation and decreased root growth potential. Short-term seedling survival was not related to nutritional regimes, seedling size or root growth potential. Differences in stem height between control seedlings and those subjected to nutrient manipulations increased in the field as a result of shoot dieback and scarce growth. In contrast, differences in root collar diameter gradually vanished. Nutrient management in the nursery showed a strong potential for modifying the morphology of *Q. suber* seedlings but the relationship between these changes and seedling survival remains elusive.

1. Introduction

The establishment of forest plantations in areas subjected to seasonal drought is strongly limited by water availability (Alloza and Vallejo, 1999; Padilla and Pugnaire 2007; Pérez-Devesa et al., 2008). When irrigation is not feasible, plantation success can be greatly dependent upon seedling morpho-functional attributes. However, there is no consensus on the set of plant traits that determines establishment success in water-limited environments, or on the nursery methodologies needed to achieve these traits (Cortina et al., 2006). Several studies have shown that seedling survival under Mediterranean conditions can be positively affected by nursery practices that enhance seedling vigor (Oliet et al., 1997, 2004; Villar-Salvador et al., 2004) and drought resistance (Vilagrosa et al., 2003). In contrast, other studies suggest that nutrient-deficient seedlings may be better prepared to withstand transplant shock and summer drought (Seva et al., 2000; Trubat et al., 2004). This apparent disagreement may be the result of the differing effects of varying intensities of summer drought, although evidence is inconclusive (Navarro et al., 2006).

Nursery cultivation regimes can strongly determine the functional characteristics of seedlings and their field performance (Burdett, 1990; Vilagrosa et al., 2003), affecting post-transplant rooting and early growth capacity (Landis, 1985; van den Driessche, 1984). Fertilization can be particularly relevant in Mediterranean areas, since nutrients ultimately influence seedling resistance to drought (van den Driessche, 1992). Fertilization may increase drought tolerance in several ways. For example, root growth potential and root hydraulic conductance increase with P and N availability (Singh and Sale, 2000; Trubat et al., 2006), and thus the ability to capture soil water may be enhanced in fertilized seedlings (Reinbott and Blevins, 1999). This can be crucial in degraded areas showing low soil fertility (Valdecantos et al., 2006). Nevertheless, N and P deficient plants commonly change their biomass accumulation and allocation patterns (Poorter and Nagel, 2000; Rubio et al., 2003), which may result in a decreased demand for water and a greater ability to endure drought. Nutrient deficiency may also enhance the accumulation of non-structural carbohydrates (Oliet et al., 2006), which may act as energy reserves and osmolites allowing seedlings to withstand transplant shock (Burdett, 1990).

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