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Does shelter enhance early seedling survival in dry environments? A test with eight Mediterranean species

Francisco M. Padilla, Juan de Dios Miranda, Rafael Ortega, Manuel Hervás, Joaquín Sánchez & Francisco I. Pugnaire

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Padilla, F.M. (corresponding author, fpadilla@eeza.csic.es), **Miranda, J. D.** (juande@eeza.csic.es) & **Pugnaire, F.I.** (fip@eeza.csic.es): Estación Experimental de Zonas Áridas, Consejo Superior de Investigaciones Científicas. Carretera de Sacramento s/n, La Cañada de San Urbano, E–04120 Almería, Spain
Ortega, R. (rortega@serfosur.com), **Hervás, M.** (mhervas@serfosur.com) & **Sánchez J.** (joaquin@serfosur.com): SERFOSUR SL, C/Gregorio Marañón 37, entreplanta 22, E–04005 Almería, Spain

Abstract

Question: Do solid-walled polyethylene tubes and mesh fabric tubes improve the short-term survival of eight Mediterranean tree and shrub species often used in the restoration of arid environments?

Location: We conducted two experimental plantations in degraded field sites in the province of Almería (SE Spain), under arid Mediterranean conditions.

Methods: One-year-old seedlings of *Ceratonia siliqua*, *Juniperus phoenicea*, *Olea europaea*, *Pinus halepensis*, *Pinus pinaster*, *Quercus coccifera*, *Quercus ilex* and *Tetraclinis articulata* were planted either sheltered by one of the above shelter tubes, or by being left unsheltered. Survival was recorded the first growing season after planting, which was a very dry season.

Results: Overall, seedling survival ranged from as little as 0% to 24%, and tree shelters consistently enhanced survival in *Quercus* species only, ranging from 16% in walled shelters to 8% in mesh shelters. Shelters failed to boost survival in the six remaining species.

Conclusion: The results of this study suggest that both walled and mesh shelters were mostly ineffective at increasing seedling survival for the Mediterranean species used in this experiment; these species coincide with those used in restoration programs. The use of shelters in restoration programs conducted in arid environments should be reconsidered, while walled shelters might be advisable for Mediterranean *Quercus* species only. Further research is necessary to develop and assess improved types of shelters for arid environments.

Introduction

Seedling survival is critical in restoration programs conducted in dry Mediterranean environments, as seedlings are very sensitive to several hazards. These include extreme temperatures and irradiance, soil desiccation, strong winds, and herbivory (Moles & Westoby 2004; Padilla et al. 2009). Excessive light and extreme temperatures may damage seedlings, strong, desiccant winds may snap twigs and exacerbate water stress caused by low rainfall, and the seedling's green sprouts may be browsed by cattle and wild fauna (Bainbridge 1994). Seedlings are mostly unable to face these threats by themselves in disturbed environments and large casualties have been reported in projects carried out in arid and semi-arid Mediterranean environments (Alloza & Vallejo 1999; Maestre et al. 2002; Sánchez et al. 2004).

Restoration initiatives in arid environments are often at risk because of a low survival rate amongst transplants. Several procedures have been developed to provide seedlings with better protection in an effort to enhance survival rates (Ludwig & Tongway 1996; Rey-Benayas 1998; Padilla & Pugnaire 2006). The use of a wide array of tree shelter-types is by far the most common practice given its low cost, ease of use, and efficiency (Bainbridge 1994; Pemán & Navarro 1998; Ponder 2003), yet their effectiveness for non-traditional species in very dry environments has yet to be examined.

Tree shelters, usually made out of plastic or similar materials, and available in several designs, can protect plants against damage from domestic or wild fauna (Dubois et al. 2000; Sharrow 2001; Chaar et al. 2008) and wind (Bainbridge 1994), while at the same time may

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