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Evaluation of unventilated treeshelters in the context of Mediterranean climate: Insights from a study on *Quercus faginea* seedlings assessed with a 3D architectural plant model

J. Pemán [a], J.J. Peguero-Pina [b], F. Valladares [c], E. Gil-Pelegrín [b,*]

[a] Department of Crop and Forest Sciences, University of Lleida, Alcalde Rovira Roure 191, E-25198 Lleida, Spain
[b] Unit of Forests Resources, CITA de Aragón, Apdo. 727, E-50080 Zaragoza, Spain
[c] Centro de Ciencias Medioambientales, CSIC, Serrano 115, E-28006 Madrid, Spain

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ABSTRACT

Unventilated treeshelters have been widely used to protect seedlings against animal browsing and prevent seed predation by rodents, when the method used is seeding instead of planting. This last method has been a common practice in reforestation with oak species in Spain, because it prevents acorn predation. Although unventilated treeshelters have been widely used in this country, the performance of such devices under Mediterranean climatic conditions is a matter that deserves further investigations. To find out if treeshelters also provide protection against abiotic stress and improve the potential carbon gain in sheltered seedlings, we carried out a light and thermal characterization of the atmosphere inside the treeshelter. Moreover, we assessed the impact of treeshelters on light capture parameters, transpiration and photosynthesis using a Y-Plant model with *Quercus faginea* seedlings. Simulations with Y-Plant have shown that the growth in sheltered seedlings was mainly in spring and was limited by the low light levels. On other hand, in summer, the low values of potential carbon gain and water use efficiency in the sheltered seedlings could limit the seedling establishment. The main limiting factor during this season was the high temperatures. Therefore, the choice of the suitable treeshelter in this region must be carefully evaluated. The treeshelter must warranty high light levels and an optimal air renovation. Photoinhibition risks in leaves of sheltered and control seedlings have not been previously shown.

1. Introduction

Seedling establishment has been considered to be influenced by seedling quality, time of planting and site environmental conditions (Burdett, 1990). However, the relative contribution of any of these factors may change when a particular reforestation program is undertaken. Thus, Palacios et al. (2009) showed that the role of the previous site preparation may be more critical than seedling quality, when reforestation with holm oak under Mediterranean conditions is considered. The response of the seedling to the environmental conditions and its ability to develop roots determines whether a seedling will survive the planting process (Grossnickle, 2005; Pemán et al., 2006). Sites to be restored can show extreme environmental conditions, which alter heat exchange processes and soil water relations in the plant, specially under subtropical (Wang et al., 2007) or Mediterranean climatic conditions (Tormo et al., 2006; Matesanz and Valladares, 2007).

Soil and atmospheric water deficits are the main limiting factors for photosynthesis and growth, although high irradiance and temperature also contribute to the reduction in leaf CO_2 assimilation; which may ultimately affect seedling establishment (Faria et al., 1998). Thus, shade can be beneficial in hot arid environments by reducing leaf temperatures, transpiration and photoinhibition (Valladares and Pearcy, 1997; Gómez-Aparicio et al., 2004; Esteso et al., 2006). The reduction of incident solar radiation in seedlings has been one of the main objectives in afforestation programs in the Mediterranean region. The traditional forest restoration models in Spain suggested the use of pine species in order to facilitate the further establishment of late successional species (Ortigosa et al., 1990), being the shading one of the most important benefits provided by these plantations. Nowadays, the use of treeshelters in afforestation could be a feasible alternative for the introduction of late successional species.

Treeshelters, which are widely used in Spanish afforestation programs, have been revealed as a valuable method for the

* Corresponding author. Tel.: +34 976 716394; fax: +34 976 716335.
E-mail address: egilp@aragon.es (E. Gil-Pelegrín).

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