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Short communication

# Emulating nurse plants to restore oak forests

Ernesto Iván Badano*, Omar Ricardo Samour-Nieva, Joel Flores

*División de Ciencias Ambientales, Instituto Potosino de Investigación Científica y Tecnológica, Camino a la Presa San José 2055, Colonia Lomas 4ta Sección, CP 78216 San Luis Potosí, México*

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ABSTRACT

Several forested areas of Mexico are dominated by oaks (*Quercus* spp.), but these forests have suffered strong changes in land use throughout the last century and need to be restored. Most of these areas, however, are within seasonally dry ecosystems and heavy losses of oak seedlings occur in the dry season. Nurse plants that ameliorate extreme environmental conditions have been proved to enhance the success of reforestation practices in these ecosystems. Nevertheless, at several sites in Mexico the density of putative nurse plants is too low to consider this practice as a viable restoration strategy. This study explores the possibility of emulating the effects of nurse plants by means of artificial-shade structures. The study areas were located at the ecological park Flor del Bosque (State of Puebla, México). At the beginning of the rainy season, seedlings of *Quercus castanea* and *Quercus laurina* were transplanted beneath and outside artificial-shade structures at two deforested areas of the park. We monitored seedling mortality during 22 weeks, until the middle of dry season; each week we recorded if individual seedlings were killed by abiotic stress or predation. We also measured chlorophyll fluorescence on seedlings to assess whether the shade structures improve their physiological performance. Comparisons of mortality rates indicated that, at both experimental sites, oak seedlings were less affected by drought and predation beneath the shade structures than outside them. Indeed, seedlings beneath these structures showed higher physiological performances. This suggests that artificial-shade structures can emulate the effects of nurse plants at deforested sites, and that this strategy could help to improve the recovery of oak forests.



## 1. Introduction

Mexico contains the largest diversity of oaks (*Quercus* spp., Fagaceae) in the world (Nixon, 1993), and oak-dominated forests cover up to 13% (269,119 km$^2$) of the country's surface. However, these forests have been logged and replaced by farms and ranches during the last 500 years, which in turn has caused the erosion of soils (Velásquez et al., 2002). For stopping and reversing this situation, the Mexican government currently promotes the restoration of these forests. Restoring oak forests remains, however, a major challenge for ecologists. This is because several areas where oak forests must be recovered, particularly in North America, coincide with the distribution of seasonally dry climates, and most oak species cannot recruit in fully sun-exposed sites because their seedlings die after the rainfall season (Peña-Ramírez and Bonfil, 2003; Pulido, 2002). For these reasons, landowners prefer to use sun-tolerant, fast-growing exotic species in order to stop desertification in deforested areas. Nevertheless, since Mexican oak forests are an irreplaceable resource because of the elevated wildlife they support, their restoration is urgently required (Koleff et al., 2004).

A current initiative for restoring native forest in these climates proposes that pioneer plants colonizing deforested areas may provide favorable microhabitats for the establishment of tall successional species (Padilla and Pugnaire, 2006). This is usually called "nurse effect" and occurs because the shaded environment beneath the canopy of nurse plants reduces the impact of extreme harsh environmental conditions (Callaway, 1995; Yoshihara et al., 2010). Despite the attractiveness of this proposal, there is a major problem behind its application: it completely depends on the density of nurse plants in the target areas. If nurse plants are scarce, this practice could be insufficiently attractive for policy makers because it may demand several years. Therefore, ecologists need to look for alternatives allowing a faster restoration of oak forest. This study focuses on this aim and proposes to use artificial shade-structures for emulating the beneficial effects of nurse plants. Specifically, we hypothesize that these structures would improve the physiological performance of oaks by ameliorating extreme environmental conditions, hence increasing the survival of plants in the target areas.

* Corresponding author. Tel.: +52 444 834 2049; fax: +52 444 834 2010.
*E-mail address:* ernesto.badano@ipicyt.edu.mx (E.I. Badano).

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