Global change and regeneration ecology of mixed oak forests in southern Spain: field patterns, physiological responses and models

Teodoro Marañón (1), Ignacio M. Pérez-Ramos (1), Itziar R. Urbieta (1), Luis V. García (1), Miguel A. Zavala (2), José Luis Quero (3,4,5) & Rafael Villar (3)
(1) IRNASE, CSIC, Avenida Reina Mercedes 10, 41012 Sevilla, Spain
(2) INIA, CIFOR, Madrid, Spain
(3) University of Córdoba, Córdoba, Spain
(4) University of Granada, Granada, Spain
(5) Wageningen University, Wageningen, The Netherlands

Regeneration ecology of mixed Quercus suber (cork oak) - Q. canariensis (Algerian oak) forests of southern Spain has been studied at different scales and levels of ecological organization. We present results on: 1) species regeneration patterns at regional scale, based on the Spanish Second Forest Inventory data; 2) environmental heterogeneity found at forest stand scale; 3) acorn removal rates along a gradient of canopy cover (light availability) as function of seed size, based on field experiments; 4) patterns of seed germination, and seedling emergence and survival along a combined gradient of light and water availability, based on seed sowing experiments; 5) differential response of oak species to combined treatments of shade and drought, under greenhouse conditions; 6) models predicting oaks’ regeneration patterns under different environmental conditions.

About 60-70 % of Q. suber and Q. canariensis stands showed evidences of a limited regeneration in Southern Spain (in Andalusia region). Human management has been a major driver of mixed oak forest composition, expanding the realized niche of cork oak at the expense of that of the Algerian oak. At the stand level, a high variability on soil phosphorus (CV=84%), zinc (76%), and light (54%) reaching the understorey (measured as global site factor) was found. Removal rates of experimentally dispersed acorns increased exponentially with plant cover (measured as leaf area index, LAI). For intermediate values of plant cover, removal rates were higher for cork oak seeds, probably due to their larger average seed size compared to that of Algerian oak seeds. Probability of seed germination and seedling emergence declined exponentially with increasing soil water content during the wet period (autumn-winter) due to heavy rains. Soil waterlogging delayed seedling emergence, which in turn decreased probability of seedling survival during summer drought. Cork oak seeds had a higher germination rate (71%) than those of Algerian oak (47%), but seedling survival was lower (37 vs. 47%). The patterns observed in the field were validated under greenhouse conditions, where the effects of light and water factors were isolated: shade conditions seemed to ameliorate, or at least not aggravate, the impact of drought on oak seedlings. For both species, seed size was more important under shade than under light conditions, in terms of resulting seedling mass. Regeneration models suggest that between-year variation in precipitation may differentially affect oak seedling establishment, promoting species coexistence. Overall, the sensitivity of early seedling life history stages to soil water (waterlogging-drought) and light availability (shade) suggests that predicted changes in the precipitation regime and in temperature-mediated water balance could have major impacts on regeneration dynamics in Mediterranean oak forests.