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Climate Change and Initial Seedling Recruitment in Mediterranean Forest: The Role of Seed Origin

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Seedling recruitment is a critical stage in plant life history because high mortality rates are often associated with the seedling processes i.e., seed germination, seedlings survival and early seedling growth [1]. Seedlings of different species die from a wide variety of causes, including many biotic and abiotic factors such as pathogens, herbivory, high or low temperatures and radiation, allelopathy and competition. Drought and soil desiccation are primary limits to establishment in many environments, as Mediterranean ecosystems, where establishment after germination is severely limited by long and dry summer periods. In such areas, seedlings are very drought-sensitive and recruitment processes are often restricted to sporadic rainfall periods or wet microsites [2].

The Mediterranean basin is one of the European regions expected to be the most affected by climate change, with temperatures expected to increase at least 2-4°C, over the next century [3]. Summer drought is the most important ecological filter to plant establishment in Mediterranean ecosystems. In the Mediterranean region, summer drought is a major factor limiting plant distribution and growth, and an increase in severity, length and frequency of summer droughts is expected in the Iberian Peninsula over the 21st century as a consequence of the climate change. Precipitation is expected to decrease during summer and autumn, with an overall decrease in water availability due to increased evapotranspiration, especially during the summer. If this change is as rapid as expected, forest climatic zone boundaries could move more rapidly than forest tree species can migrate [4].

Plants exhibit many morphological and physiological adaptations to cope with this environmental stress [5]. Local adaptation is a key step in the process of diversification of species [6]. Specifically, while at broad spatial scales the climate plays a preponderant role, at smaller spatial scales, physical and chemical soil properties may represent a key factor for local adaptation [7], particularly on early life stages, as seedling emergence and survival [8]. Facing the environmental changes, trees can respond in different ways or can migrate through seed movement to more suitable areas and thus maintain their climatic distribution. These possibilities have been widely considered as responses to the current climate change, but populations may also be able to evolve and genetically adapt to new conditions. Nevertheless, locally adapted populations have the highest fitness when compared with other populations at their growing site [9].

A detailed understanding of the laws and processes that determine the ecosystem dynamics is essential in order to develop well-adjusted forestry management plans in a climate change scenario. This includes a good understanding of natural regeneration processes since natural regeneration can become an important component of stand resilience. Moreover, climatic changes may reduce the success of natural regeneration and hence require adjustments to silvicultural practices. Different studies have been performed to evaluate pine responses to climate change, i.e., reciprocal sowing experiments designed to study local adaptation to the environmental conditions of seedling establishment. In this regard, pine seed origin could assess better adaptation to climate changing conditions. For example, northern provenances of Scots pine transferred south to warmer climates had higher growth than at their original location [10]. Thus the northern populations are likely to benefit from the warming climate. However, this large-scale study also predicted that the southernmost populations in the northern hemisphere are likely to suffer from the warming climate [11]. Findings of increased growth upon climate change in the expected elevated temperatures have also been made in experimental studies.

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