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Effect of light conditions and salinity on germination behaviour and early growth of umbrella pine (*Pinus pinea* L.) seed

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SUMMARY

Pinus pinea L. (umbrella pine) is a tree species distributed around the Mediterranean basin. The ecological, landscape, recreational and soil conservation uses of *P. pinea*, and its aesthetic value, make this species important for landscape planning and multipurpose forestry. In this study, seeds of *P. pinea* were collected from the two principal forests where the species is found in Greece (the Strofylia Forest, southern Greece, and the Sithonia Peninsula, northern Greece), in order to examine the effects of light conditions and soil salinity, two important environmental factors, on seed germination behaviour and early growth. The effect of light alone on seed germination was ascertained under different light regimes; while, to investigate the effect of salinity, seeds maintained in continuous light were watered with varying concentrations of NaCl and, after germination, the early growth of seedlings was monitored. The findings showed that the percentage germination of *P. pinea* seed is high and does not depend on light or dark conditions, while salinity markedly inhibited seed germination at NaCl concentrations of 0.05 M and above. Seedlings raised under saline conditions (0.02 M NaCl) were significantly smaller than those of the controls, especially in their below-ground structures.

Pinus pinea L. (umbrella pine or Italian stone pine) is a tree species that is widespread around the Mediterranean basin (Barbero *et al.*, 1998). It is a dramatic ornamental tree, widely planted in parks and gardens throughout the World (Fady *et al.*, 2004). The ecological, landscape, recreational, and soil conservation uses of *P. pinea*, the high economic yield of its two principal products, wood and pinyon nuts, its ability to withstand low intensity fires (Tapias *et al.*, 2004), and its high aesthetic value, make this species important for landscape planning and multipurpose forestry. As a consequence, the interests of landscape designers, forest managers, growers and researchers in the ecology of the species have increased (Calama *et al.*, 2003).

P. pinea is propagated readily from seeds, which have been reported to be resilient and long-lived (Ranaldi *et al.*, 2003). However, the species faces regeneration problems in many localities. While the reasons for this phenomenon have not yet been identified, several hypotheses have been proposed (Moussouris and Regato, 1999). Although the species is considered highly light-demanding throughout its life (Moulopoulos, 1962), the effects of light conditions on seedling emergence have not yet been studied. In addition, the geographical distribution of *P. pinea*, as well as its aesthetic use mainly along coasts, and thus in saline soil, could pose possible problems for species establishment. Along the coastline of Tuscany, low concentrations of Na⁺ and Cl⁻ ions have been found in the needles and woody tissues of *P. pinea* trees, indicating absorption of salt (Teobaldelli *et al.*, 2004). In general, salinity inhibits seed germination (Lombardi *et al.*, 1998, Tobe *et al.*, 1999; Koslowski, 2002),

primarily by lowering the osmotic potential of the soil solution, thus inhibiting water absorption by seeds (Katembe *et al.*, 1998), but also through salt toxicity to the embryo. High ion contents in plant cells induce changes in protein hydration (Zekri, 1993).

Little is known about the effects of environmental conditions on seed germination and early growth in *P. pinea* (Baskin and Baskin, 1998). Previous studies (Skordilis and Thanos, 1997; Escudero *et al.*, 2002) reported a high variability in seed germination of *P. pinea* that was related to environmental conditions and variations in populations.

Thus, the aim of this study was to examine the effect of light conditions and salinity on seed germination and early growth in two populations of *P. pinea*, from northern and southern Greece. The hypothesis was that environmental factors would have a significant effect on seed germination, and thus an analysis of their influence could contribute to a better understanding of the ecology of the species.

MATERIALS AND METHODS

Pinus pinea seeds were collected by hand from the Strofylia Forest, a coastal forest located in the western Peloponnisos, in southern Greece, and from the Sithonia Peninsula, Chalkidiki, in northern Greece. At each site, cones were collected from five different locations, and placed in the sun to open. The seeds were removed and stored at 4°C until germination tests. Prior to germination, seeds were immersed in water and any that floated were removed. Seeds were then dusted with fungicide (Captan, Mercap 83 WP; Papaeconomou Agrochemica, Thessaloniki, Greece).

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