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# Effects of soil burn severity on germination and initial establishment of maritime pine seedlings, under greenhouse conditions, in two contrasting experimentally burned soils

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**Abstract.** The effects of soil burn severity on initial establishment of maritime pine in burned areas are not well known. Many factors may interact in the field, thus making it difficult to determine the exact role played by soil burn severity in the post-fire regeneration process. Monoliths of two contrasting soils – an acid, coarse-textured soil, with high organic matter content, and a neutral heavy-textured soil with low organic matter content – were experimentally burned to provide two markedly different levels of soil burn severity. The burned monoliths were sown with *Pinus pinaster* seeds and then placed in a greenhouse under a preselected water regime to determine the effect of burn severity on emergence and initial establishment of pine seedlings. High soil burn severity in the coarse-textured soils delayed germination, increased mortality and temporarily decreased the height of pine seedlings in the first year after sowing. This response was affected by: soil heating level, soil C consumption, post-fire soil C, depth of burn and post-fire duff-depth. Ash had no influence on the above processes. These factors did not explain the variability in the response of regeneration variables in the heavy-textured soils. The applicability of the results to field conditions is discussed.

**Additional keywords:** fire, *Pinus pinaster*, post-fire regeneration.

## Introduction

The role played by fire severity in post-fire regeneration has been analysed in different ecosystems, such as boreal forest (e.g. Schimmel and Granström 1996; Johnstone and Chapin 2006), North American western conifer forest (e.g. Turner *et al*. 1994; Laughlin and Fulé 2008) and also in some shrub-dominated ecosystems (e.g. Keeley *et al*. 2005, 2008; Grace and Keeley 2006), but its influence in Mediterranean forest has been less explored (Pausas *et al*. 2003; Broncano and Retana 2004; Vega *et al*. 2008, 2010).

Researchers have defined 'fire severity' in different ways based on which post-fire effects on the study system they are concerned with. However, Keeley (2009) has suggested that 'fire severity' should be restricted to measures of aboveground and belowground organic matter consumption by fire, and when applied to soil, should be referred to as 'soil burn severity'. The reduction in the depth of soil organic horizons (depth of burn) has frequently been used as a measure of soil burn severity, either alone, or combined with visual signs of the degree of combustion of woody residues (Ryan and Noste 1985; Schimmel and Granström 1996; Wang 2002; Neary *et al*. 2005; Kemball *et al*. 2006). Moreover, post-fire duff depth has been shown to be an important factor in explaining the success of conifer seedling germination and establishment following fire in boreal forests (Charron and Greene 2002; Johnstone and Chapin 2006; Kemball *et al*. 2006). Most studies in this type of forest have revealed much higher rates of establishment on shallow duff layers or mineral soil seedbeds because deeper organic layers frequently dry out in the summer, resulting in higher seedling mortality if roots have not yet reached the mineral soil (Chrosciewicz 1974; Zasada *et al*. 1983; Herr and Duchesne 1995; Charron and Greene 2002).

In Mediterranean forests, the duff layer is shallower and conifer seed mass is much greater than in boreal species (e.g. the seed mass of *Pinus pinaster* Ait. is 7.5 times greater than that of *P. banksiana*; Keeley and Zedler 1998), and therefore seedling roots should quickly reach the mineral soil. Nonetheless, there are conflicting results as to whether a thicker remaining duff layer may be beneficial for post-fire *P. pinaster* seedling establishment in the extended dry periods in Mediterranean regions, as a result of reduced water evaporation from the soil. For example, Castro *et al*. (1990), Madrigal *et al*. (2005) and Vega *et al*. (2008) reported a positive effect of duff consumption, but Fernández *et al*. (2008) did not detect it.

The reduction of soil organic matter by combustion during fire may result in many changes to soil properties that are relevant to seedling success, such as cation exchange capacity, pH and nutrient availability (DeBano *et al*. 1998; Neary *et al*.



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