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The germination niches of grassland species targeted for restoration: effects of seed pre-treatments

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Abstract

Restoration of semi-natural grassland communities involves a combination of (1) sward disturbance to create a temporal window for establishment, and (2) target species introduction, the latter usually by seed sowing. With great regularity, particular species establish only poorly. More reliable establishment could improve outcome of restoration projects and increase cost-effectiveness. We investigated the abiotic germination niche of ten poorly establishing calcareous grassland species by simultaneously exploring the effects of moisture and light availability and temperature fluctuation on percentage germination and speed of germination. We also investigated the effects of three different pre-treatments used to enhance seed germination – cold-stratification, osmotic priming and priming in combination with gibberellic acid (GA_3) – and how these affected abiotic germination niches. Species varied markedly in width of abiotic germination niche, ranging from *Carex flacca* with very strict abiotic requirements, to several species reliably germinating across the whole range of abiotic conditions. Our results suggest pronounced differences between species in gap requirements for establishment. Germination was improved in most species by at least one pre-treatment. Evidence for positive effects of adding GA_3 to seed priming solutions was limited. In several species, pre-treated seeds germinated under a wider range of abiotic conditions than untreated seeds. Improved knowledge of species-specific germination niches and the effects of seed pre-treatments may help to improve species establishment by sowing, and to identify species for which sowing at a later stage of restoration or introduction as small plants may represent a more viable strategy.

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Introduction

European calcareous grasslands support a diverse flora and fauna and have high conservation and cultural values (Hillier *et al.*, 1990; WallisDeVries *et al.*, 2002). Once widespread, they have declined massively due to agricultural intensification and abandonment, both on the European mainland (WallisDeVries *et al.*, 2002) and in the UK (Braithwaite *et al.*, 2006). Remaining fragments are often small and isolated from each other, resulting in an increased risk to the persistence of many of the more specialist species (Fischer and Stöcklin, 1997; Bruun, 2000). Furthermore, the effects of past habitat fragmentation on grassland biodiversity may not yet have become fully manifest (Helm *et al.*, 2006). Both diversification of degraded sites and creation of additional semi-natural grassland are urgently required to help avert further species loss (Walker *et al.*, 2004), and these actions are included in conservation initiatives such as the UK Biodiversity Action Plan (UK Biodiversity Group, 1998).

After extended periods of agricultural intensification or abandonment, desirable target species are often no longer present in the seed bank (Davies and Waite, 1998; Bossuyt *et al.*, 2006; Fagan *et al.*, 2010). Natural recolonization via seed rain or seed transfer by grazing livestock is possible if source habitats are nearby (Barbaro *et al.*, 2001; Fagan *et al.*, 2008). However, this process is often slow and unreliable even under favourable conditions, and frequently leads to floristically impoverished communities (Stampfli and Zeiter, 1999). Thus, active introduction is usually required (Pywell *et al.*, 2002, 2007).

There are various methods for species introduction. Planting usually works well in terms of plant survival (Wells *et al.*, 1989; Davies *et al.*, 1999; Wallin *et al.*, 2009) but is both labour- and cost-intensive. It is most often