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Abstract

Early plant life-history stages, such as germination and seedling establishment, are considered highly vulnerable to climate change and are important to species persistence because they could represent a bottleneck to future recruitment. The strong relationship between the changing climatic factors and these life stages suggests that they will be significantly affected in the future. Here, we present the results of a field manipulative experiment where we looked at how (i) seed maturation, (ii) seed germination and (iii) seedling establishment of ten alpine grassland species (graminoids and forbs) will respond to future warmer temperatures, a decrease in precipitation and more frequent fires. For this, during two snow-free seasons (2020-2021 and 2021-2022), we established a two-factorial experiment at the Australian Alps where our factors were: a future drier and warmer climate and post-fire conditions. We created warmer and drier conditions by using modified open-top chambers that simultaneously increased the soil temperature and reduced the soil moisture. To simulate post-fire conditions, we burnt small patches of vegetation and added smoke water. Then, to determine the effects of our experimental treatments in the studied life stages, we: (i) collected seeds from plants inside the chambers and contrasted their mass, size, viability and cotyledons size and greenness against seeds collected in control plots; (ii) we buried seeds from studied species inside mesh bags and recorded their monthly germination; and (iii) we planted seedlings of studied species and measured their monthly growth and survival. Overall, we find negative and neutral effects of our experimental treatments in the studied life stages. (i) Seeds from plants inside the chambers were significantly lighter and smaller and had smaller and less green cotyledons in almost all species. (ii) The final proportion of germinated seeds was negatively affected by warmer and drier conditions in all species. More importantly, warmer and drier conditions also affected the germination time, where most germination occurred later in the snow-free season compared to control sites. We did not detect any effect of post-fire treatment in seed germination. (iii) Seedling survival and growth were strongly affected by post-fire conditions, where most planted seedlings did not survive. Seedlings were affected less by warmer and drier conditions, but we still recorded more mortality and less growth than control plots. Finally, we discuss some of the potential implications of our findings and their significance to our understanding of future plant recruitment in alpine areas.