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Comparative recruitment success of pine provenances (Pinus sylvestris, Pinus nigra) under simulated climate change in the Swiss Rhone valley

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Low elevation Scots pine forests of European inner-alpine dry valleys may potentially disappear under continued climate warming, largely in response to increased warming and drought effects. In the upper Rhone valley, the driest region in Switzerland, increased Scots pine mortality in mature forest stands and sparse tree establishment after a large-scale forest fire already give evidence for ongoing climate change. Furthermore, vegetation models predict a decline of Scots pine (Pinus sylvestris) and Pubescent oak (Quercus pubescens) even under a moderate temperature increase of 2-3°C. A decline of tree species in the region may lead to a transition from forest to a steppe-like vegetation. Such a change is of considerable concern for both biodiversity and natural hazard protection. Although changing climate conditions affect all life stages of a tree, its most vulnerable stage is recruitment. We tested P. sylvestris and P. nigra seedlings to simulated temperature increase and water stress, using seeds from the upper Rhone valley, Switzerland (CH), and from Peñyagolosa, Spain (ES). The experiment was located outdoors at the bottom of the Rhone Valley. Treatments consisted of factorial combinations of 3 precipitation regimes (‘wet spring-wet summer’, ‘dry spring-dry summer’ and ‘wet spring-dry summer’) and 3 soil heating levels (+0 °C, +2.5 °C, +5 °C). Automatically operated shelters intercepted natural rainfall and different precipitation regimes were simulated by manual irrigation. We found significantly lower germination rates under dry conditions compared to wet conditions, whereas soil temperature affected germination rates only for P. nigra and when elevated by 5°C. Contrastingly, an increase of soil temperatures by 2.5 °C already caused a substantial decrease of survival rates under both ‘dry spring-dry summer’ and ‘wet spring-dry summer’ conditions. Precipitation regime was more important for survival than temperature increase. Seasonality of precipitation had distinct effects on the number of seedlings present after the first growing season. In the ‘wet spring-dry summer’ treatment, a high germination rate overcompensated for low summer survival rates, resulting in higher seedling numbers at the end of the growing season in comparison to the ‘dry spring-dry summer’ treatment. Biomass strongly depended on precipitation regime (‘wet spring-wet summer’ > ‘dry spring-dry summer’ > ‘wet spring-dry summer’), as well as having a strong provenance component with higher biomass recorded for Spanish P. sylvestris provenance than for the Swiss provenance under dry conditions. Our results imply that impacts of climate warming on tree recruitment will strongly depend on the way precipitation quantity and patterns change in the future, and early recruitment stages of provenances clearly differ in their ability to cope with drought.