

Legume germination is delayed in dry soils and in sterile soils devoid of microbial mutualists: implications for upward range expansions

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Abstract

Climate change is affecting species and their mutualists and can lead to interaction weakening and loss. Through independent shifts in partner phenology and distribution, climatic stress can separate mutualists, leading to alterations in partner functional traits and fitness. Here, we explored the effects of drying soils and the loss of microbial mutualists via soil sterilization on legume germination success and phenology, focusing on how a loss of mutualisms with soil microbial species can alter legume early life traits. In particular, we assessed the effects of mutualism loss via soil sterilization, increased drought, or introduction to novel soils found beyond the current distributions of two focal legume species in subalpine environments. Through common garden experiments in controlled environments, we found evidence that soil sterilization (and consequent microbial absence) and dry soils caused phenological delays of 2-5 weeks in germination date, likely as a result of interaction loss between legumes and germination-promoting soil microbes, such as mutualistic rhizobia. Delays in germination caused by a mismatch between legumes and beneficial microbes could negatively affect legume fitness through increased plant-plant competition later in the season. Additionally, we found evidence of the presence of beneficial microbes beyond the current elevational range of our focal legumes which may allow for expansion of the leading edge, though harsh abiotic factors in the alpine may hinder this. Alterations in the strength of soil microbe-legume mutualisms may lead to reduced fitness and altered demography for both soil microbes and legumes.

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