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Are water and nutrient limitations promoting complementarity in minimal plant communities?

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It has been hypothesized that resource limitation promotes complementary resource use by different species in a plant community. According to this hypothesis, more diverse communities would use available resources more efficiently by exploiting contrasting niches. As a result, diverse communities would have higher overall productivity than monospecific stands in resource-limited systems. While this hypothesis has been tested in various experiments, less attention has been devoted to combined water and nutrient limitation, and variations in complementarity vs. selection effects through time. Understanding these dynamics is particularly important in the context of climatic changes that might alter resource availability—specifically the timing and amount of rainfall. To assess how combined resource limitation alters allocation and productivity in monocultures vs. species mixtures, we set up a pot experiment with full factorial manipulation of both water and nutrient availability, for monocultures and mixtures of two Salix species. To capture expected increases in rainfall intermittency, water availability was manipulated by changing the timing of the water additions—not the total amount provided. Thus, in the infrequent irrigation treatment, longer dry periods occurred between larger water additions, leading to lower water availability at the end of each dry period, compared to the frequent irrigation treatment. The selected species differ in functional traits such as specific leaf area and stem diameter to height ratio, suggesting that they might fill different niches thereby allowing us to test the complementarity hypothesis despite them being closely related. With this experimental set up, we found that the Salix species with higher growth rate suffered the most water stress and that nutrient limitation caused higher root-to-shoot biomass ratio in both species. Both effects were expected, as larger plants growing in nutrient-rich conditions deplete water resources faster, and it is well known that nutrient shortage promotes allocation belowground. Regarding diversity effects, we found that both complementarity and net diversity effects increased through time as resource competition increased, and contrary to expectations were overall higher in the high nutrient supply and frequent watering treatments. These results suggest stronger interactions among the relatively larger plants growing under resource-rich conditions, compared to weak interactions among small plants. In turn, these stronger interactions among large plants might lead to more marked niche separation allowing for resource use complementarity.