Impacts of soil microbial communities on plant physiological response to drought

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LANL, B-11

ABSTRACT: The global population is expected to reach 9.1 billion by 2050, requiring a 70% increase in food production compared to 2005. However, climate change, including drought, threatens vegetation around the world. It has been suggested that soil microbial communities can improve plant productivity and survival but currently we do not understand how this works. A major knowledge gap is how soil microbial communities alter plant physiological responses to drought. To address this knowledge gap, we examined plant physiological response to drought as a function of soil microbial community composition. We hypothesized that microbial community composition will affect the following plant functions: germination, growth, drought tolerance, photosynthesis, stomatal conductance, growth, and wilting.

To test these hypotheses, seeds of a fast-growing C4 grass, blue grama (*Bouteloua gracilis*) were planted in sterilized sand (the control treatment) or sterilized sand inoculated with soil microbial communities from 15 geographically distinct New Mexico soils. The 15 soil microbial communities were selected to inoculate plants because they exhibited functional differences in carbon cycling. After substantial growth (14 weeks), drought was imposed. Plant physiological measurements were taken before, during, and after drought.

One month after planting, germination and shoot height were significantly greater in inoculated plants compared to controls. Inoculated plants maintained greater rates of photosynthesis and soil moisture than controls until soil moisture declined to zero. The greater soil moisture allowed inoculated plants to have lower drought tolerance than the control group. However as a result, inoculated plants were more susceptible to zero soil moisture as indicated by significantly lower stomatal conductance and greater wilting compared to controls. Among the inoculated plants, plant functional differences were linked to the composition of fungal communities used for inoculation. Community analysis showed that community composition was linked to plant height and drought tolerance.

These data suggest that soil microbes promote blue grama's opportunistic life history strategy where it is active until it enters dormancy in response to drought. This work improves our understanding of plant:microbial interactions, and how soil microbial communities influence plant function during drought, a key aspect of understanding vegetation responses to climate change.