Do Arbuscular Mycorrhizal Fungi Help Grasses in Heatwaves?

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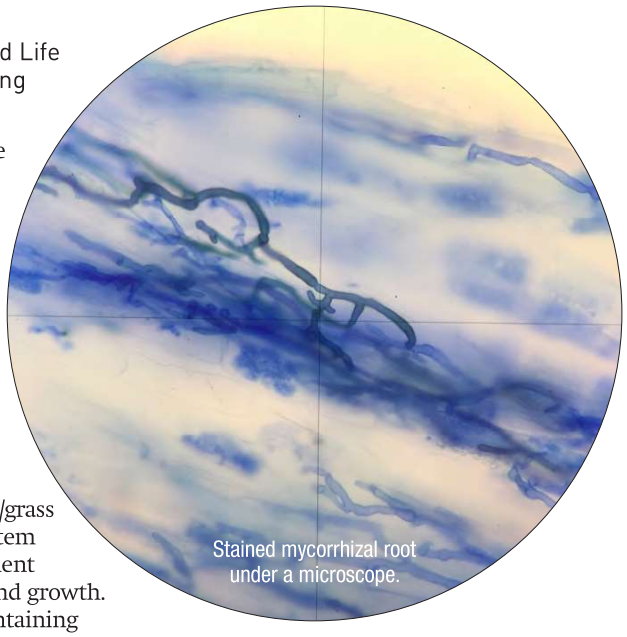
Heatwaves will become more frequent and intense under climate change. Heatwaves are highly stressful for plants as they are associated with periods of low rainfall and high heat. Facilitative interactions may help plants cope with heatwaves. Fungal symbionts such as arbuscular mycorrhizal fungi (AMF) are ubiquitous in terrestrial grasses, but their role in alleviating plant stress in response to stress events, such as heatwaves, remains poorly understood.

Agricultural studies show that AMF can mitigate the negative effects of heat and drought separately, but few studies investigate the ecologically relevant conditions of both heat and water stress over several days. While there is some information that AMF may improve plant tolerance to stress events, the data is primarily based on some agricultural species; we know nothing about native grasses and how AMF may help in survival. Increasing our understanding of how these fungal symbionts protect grasses and how this may vary amongst species is crucial in predicting community change in grasslands to increasingly more frequent heatwave and drought events.

Combined heatwave and drought events present unique challenges for plants. As water becomes limited, plants can limit water loss by closing pores in the leaf, called stomata. Water loss through stomata can cool leaves during high temperatures, but the leaves begin to heat up if these stomates close. Thus, high temperatures and water limitations present a unique problem for plants. The project will attempt to understand how AMF may modify plant water use. AMF may help plants use water more efficiently and could improve water scavenging capabilities. The project will use stable carbon isotope analysis, which will give a carbon isotope ratio (^{12}C:^{13}C); the higher the ratio, the lower the water use efficiency of the plant and thus the greater stress the plant is under.

Grasslands are one of the most threatened ecosystems globally. Major threats include overgrazing and invasion by exotic pasture grasses. Grasslands act as some of the largest carbon sinks, signalling their high value. The increasing frequency of heatwaves and low rain periods may modify AMF/grass relationships and ecosystem function, including nutrient acquisition, water use, and growth. Thus, restoring and maintaining ecosystem function is essential for biodiversity conservation and land managers and agricultural practices.



Stained mycorrhizal root under a microscope.

The researcher will conduct a heat and water stress experiment to determine the role of AMF as a facilitator. The researcher will undertake fieldwork to collect soil inoculum containing AMF spores from natural grassland areas. The inoculate will be added to sterile soils within a glasshouse experiment on several native grass species to investigate how heat and water stress (and their combination) change colonisation and influence plant physiology and growth.

The project aims to answer the following questions:

1. How does AMF help native grasses cope with extreme stress and heatwave events?, and
2. How does the AMF community assemblage change in response to extreme stress events, and how does this influence the role of AMF as a facilitator?

The project will identify how plant physiological and ecological responses to heat waves differ when grown with and without AMF and identify what physiological and morphological mechanisms AMF may alter to enhance the hosts' performance during stress.

The project will measure how host responses vary between species and identify differences in AMF associated with different grass species.

The project will also outsource stable carbon isotope analysis to help answer some of the project aims in understanding how AMF changes plant physiological responses under stress, particularly how water use efficiency may be altered.

Overall, the project results will build an understanding of AMF symbioses under a changing climate and help us predict how native plant communities may respond under elevated stress. Knowing how these fungi facilitate their hosts during these stress events will be vital in predicting shifts in native vegetation community composition and inform management, ecosystem restoration, and broad agricultural applications.

Top: Shae Jones is a PhD candidate at the University of Wollongong.

FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY will be used to pay for stable carbon isotope analysis to determine how arbuscular mycorrhizal fungi (AMF) may be modifying plant water use. The analysis will be outsourced to an external lab.