Elitenetzwerk Bayern

Einblicke in die Forschungsarbeit

MASTER THESIS

“Mycorrhizae, Maize & Drought”

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Elite Graduate Program “Global Change Ecology”

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Fungi Effect Maize Response to Drought

Kelly Heroux earned a MSc Global Change Ecology at Bayreuth University as a member of the Elite Network of Bavaria. For her thesis, she collaborated with the Soil Physics Department on an experiment which demonstrated an important link between mycorrhizal root colonization in maize and overall plant response to drought. Her work provides insight into practices to increase drought resilience in crops, as well as refining predictions for water fluxes in the soil-plant-air continuum.

Link Between Mycorrhiza and Maize During Drought

Drought is the primary threat to agricultural production, causing declines in yield and increasing plant mortality. Stomata are tiny openings on the epidermis of leaves that allow for water vapor and other gas exchanges. Stomata need to open to release oxygen as a product of photosynthesis. Stomata behavior has profound implications for water fluxes between the soil and the atmosphere and yet it remains unknown what exactly triggers stomata to close when there is a soil water deficit, or drought. Meanwhile, it is understood that arbuscular mycorrhizae fungi (AMF) improve the water retention quality of soils and root water uptake. Kelly's study aimed to demonstrate a link between the influence of AMF on the water status of maize plants when exposed to drought. Soil matric potential is the relative availability of the amount of water held in the soil for plant uptake/use. Kelly hypothesized that soils in the rhizosphere of plants inoculated with AMF have a less severe drop in soil matric potential, allowing for increased and extended water uptake at the soil-root interface during soil drying. Subsequently, as soil dried, she expected an enhanced plant water status would be observed for inoculated plants, allowing inoculated plants to endure drought conditions longer than those without AMF.

To test these hypotheses, Kelly planted over sixty maize plants, including four genotypes. She inoculated half of each genotype with AMF spores and grew the plants in a climate chamber where atmospheric conditions were controlled, and soil and plant water statuses could be closely observed. Once the plants were mature, Kelly ceased watering and adjusted the chamber's climate to impose drought conditions. For the next seven days, she measured transpiration rates, soil water content and leaf water potential. When the plants had died, she harvested them to measure above- and belowground biomass, root morphology, and root colonization.

AMF Symbiosis Effected Above-Ground Response to Drought

The results demonstrated that, as the soil dried, AMF symbiosis allowed for a more gradual decline of leaf water potential, facilitating both higher and sustained transpiration rates when compared with the plants grown without AMF.

Kelly's research showed that AMF supported the maize plants in maintaining hydraulic continuity between the roots and drying soils, reducing the drop in matric potential at the root-soil interface. Her findings express the importance in linking AMF colonization with plant hydraulics and stomatal conductance to improve plant resistance to drought, as well as supporting more precise predictions of plant response to soil drying, especially in the face of climate change.

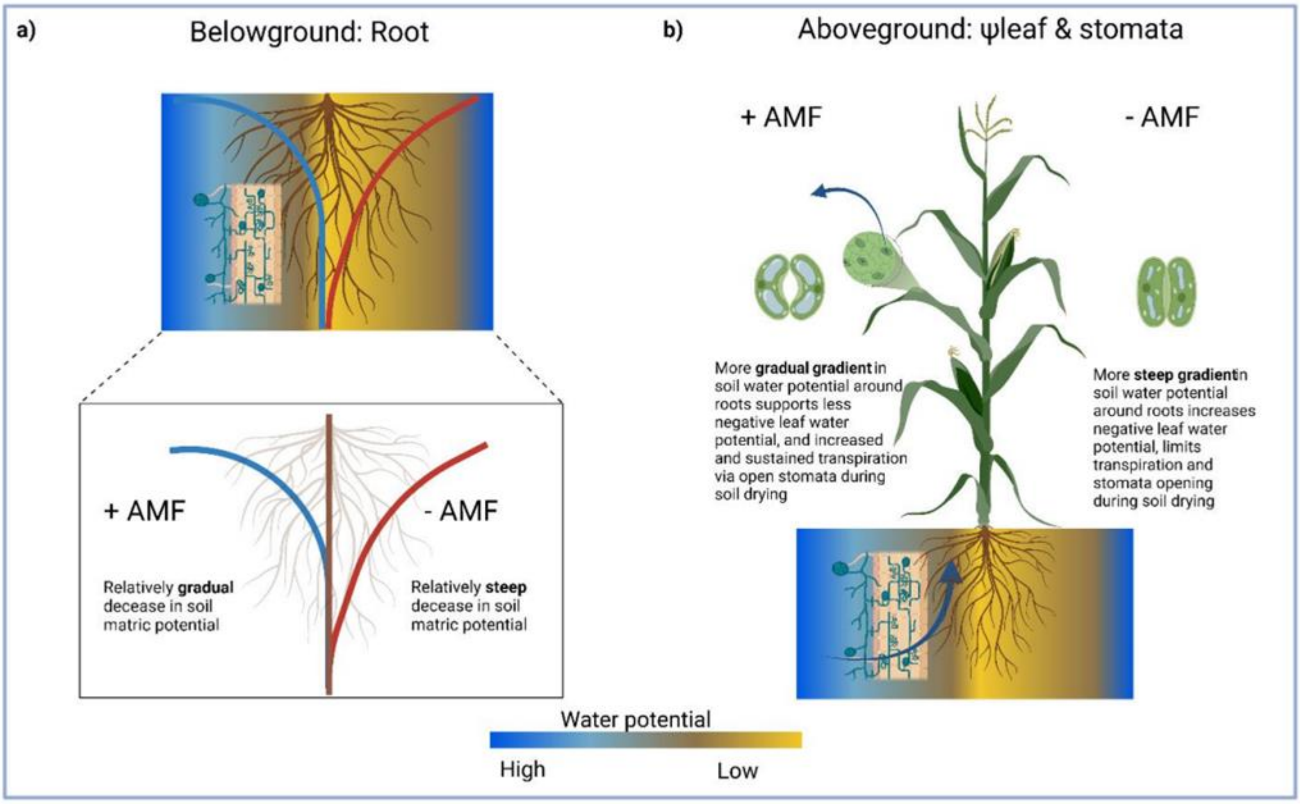

Figure 1. *Graphical abstract: **a)** Hypothesized influence of AMF inoculation (+AMF) on soil matric potential. AMF symbiosis is understood to support radial movement of water toward plant roots, extend contact of colonized roots to otherwise inaccessible soil water resources, and to store water resources, thus buffering the decline in soil matric potential during soil drying. This study aims to show that by supporting a more gradual decrease in soil matric potential, **b)** leaf water potential in AMF inoculated plants remains less negative, transpiration rates are sustained longer, and corresponding stomata closure during soil drying is demonstrated to be concretely linked with belowground hydraulic conductance. Created with BioRender.com.*

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