

DNA Stable Isotope Probing Reveals Beneficial Effects of Plant-Associated Fungi on Bacterial Communities in Drought-Affected Soil

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Thank you!

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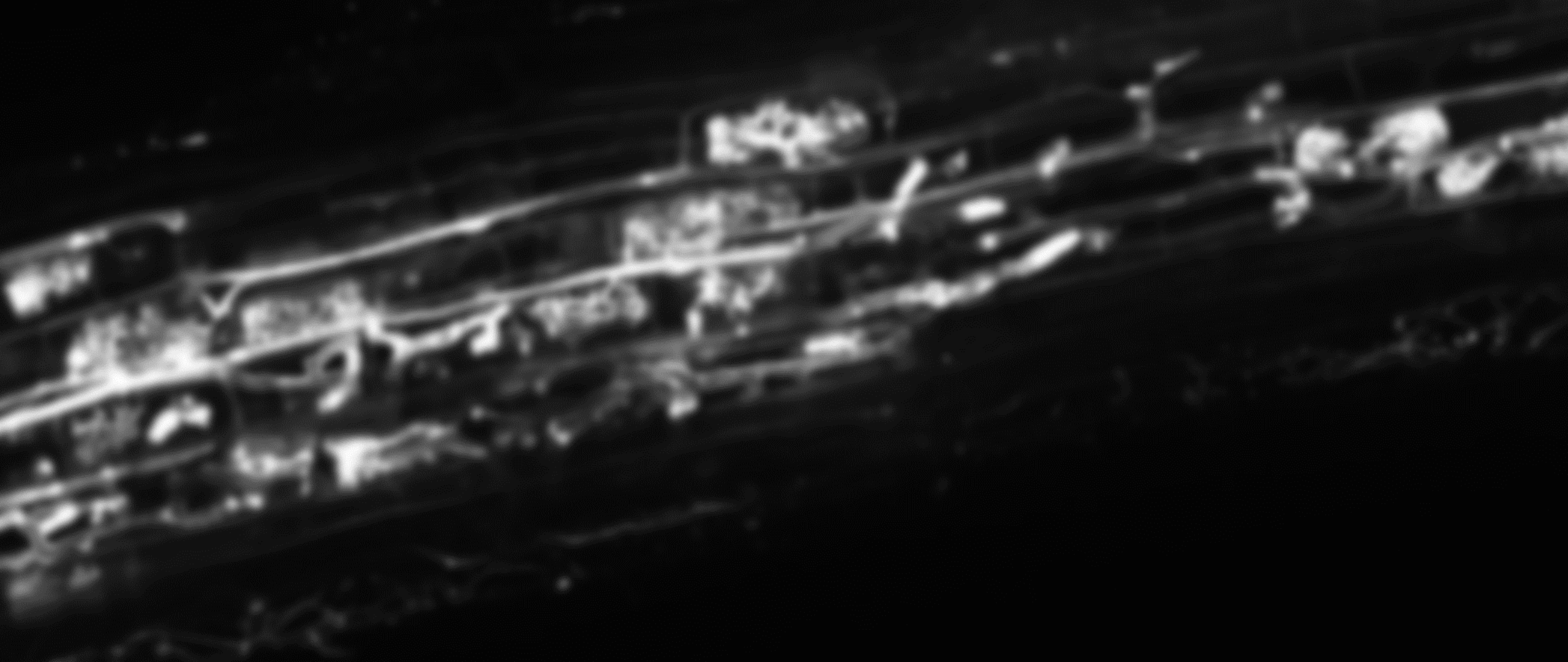


U.S. DEPARTMENT OF
ENERGY

Can we harness microbial synergies for productive, profitable, efficient, resilient agricultural systems?



Can plant-associated fungi support profitable and resilient agricultural systems?



How do microbial interactions influence resource exchange and resilience in the hyphosphere?



20 μm

How do plant-associated fungi mediate microbial response to environmental stress (drought)?

Drought is predicted to increase in severity and frequency

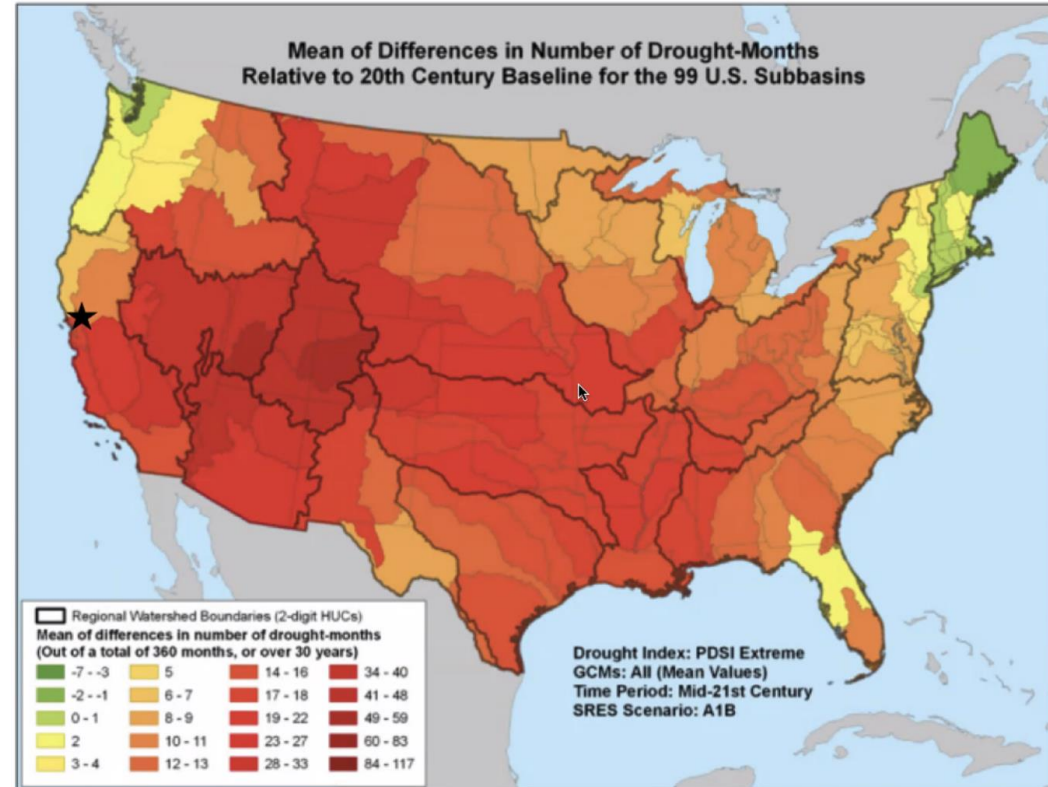
(Dai 2012; Sherwood & Fu 2014)

Drought influences microbial structure and function

(Hueso et al 2012; Bouskill et al 2013; Acosta-Martinez et al 2014)

AMF support plant function during drought

(Duan et al 1996; Morte et al 2000; Gong et al 2015)



(Strezepek et al 2010)

How do plant-associated fungi mediate microbial response to drought?

→ Drought alters microbial structure and function

H1: Plant-associated fungi mitigate the effect of drought on soil microbes

H2: Microbial responses to different plant-associated fungi are distinct

How do plant-associated fungi mediate microbial response to drought?

→ Drought alters microbial structure and function

H1: Plant-associated fungi mitigate the effect of drought on soil microbes

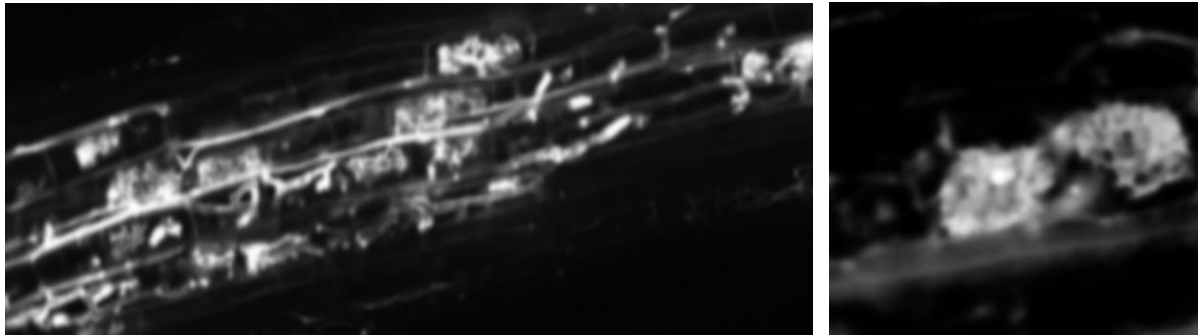
H2: Microbial responses to different plant-associated fungi are distinct

Rhizophagus irregularis

→ Arbuscular mycorrhizal fungus

→ Obligate symbiont

→ Reduced enzymatic repertoire

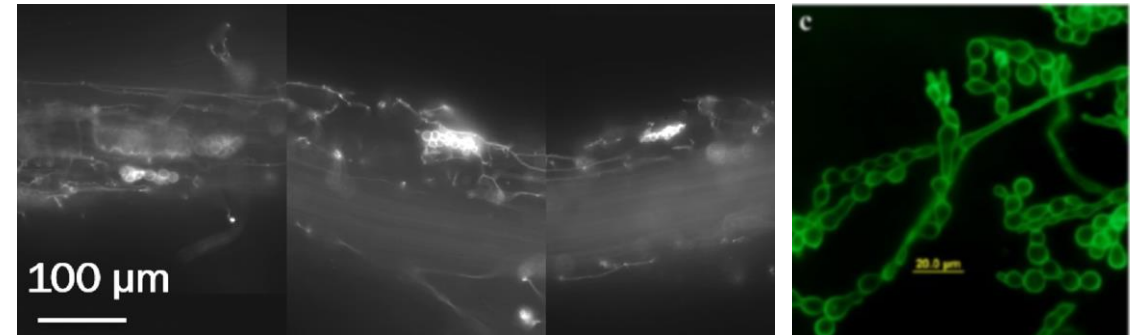


Serendipita bescii

→ Sebaciniales fungus

→ Facultative symbiont

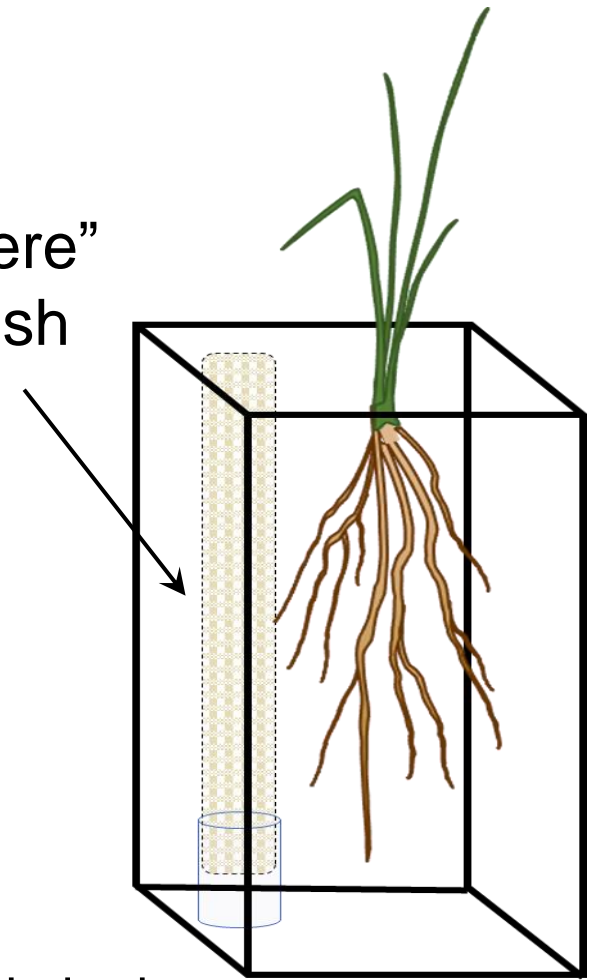
→ Wider enzymatic repertoire



Experimental design



“hyphosphere”
25 μm mesh



Treatments

Moisture: Replete, Limited

Fungi: Uninoculated, *R. irregularis*, *S. bescii*

C isotopes: $^{13}\text{CO}_2$, $^{12}\text{CO}_2$

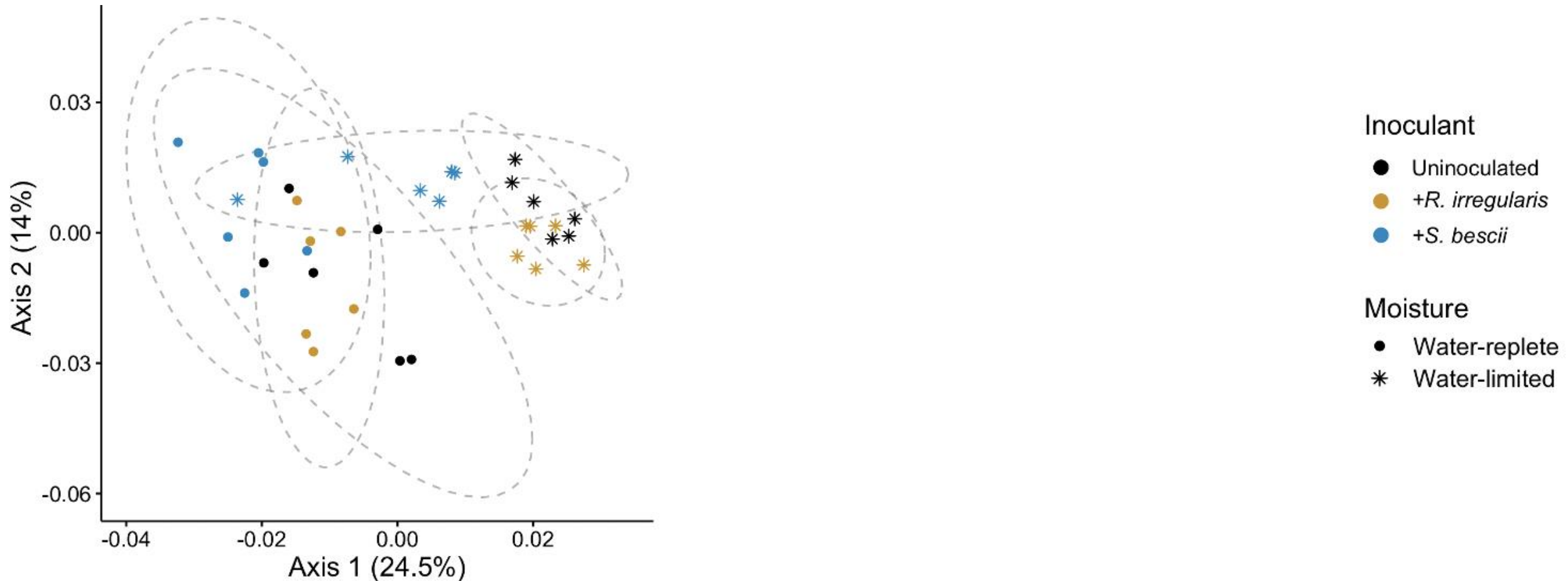
Timepoints: 5, 8, 12 weeks

Locations: Hyphosphere, Rhizosphere

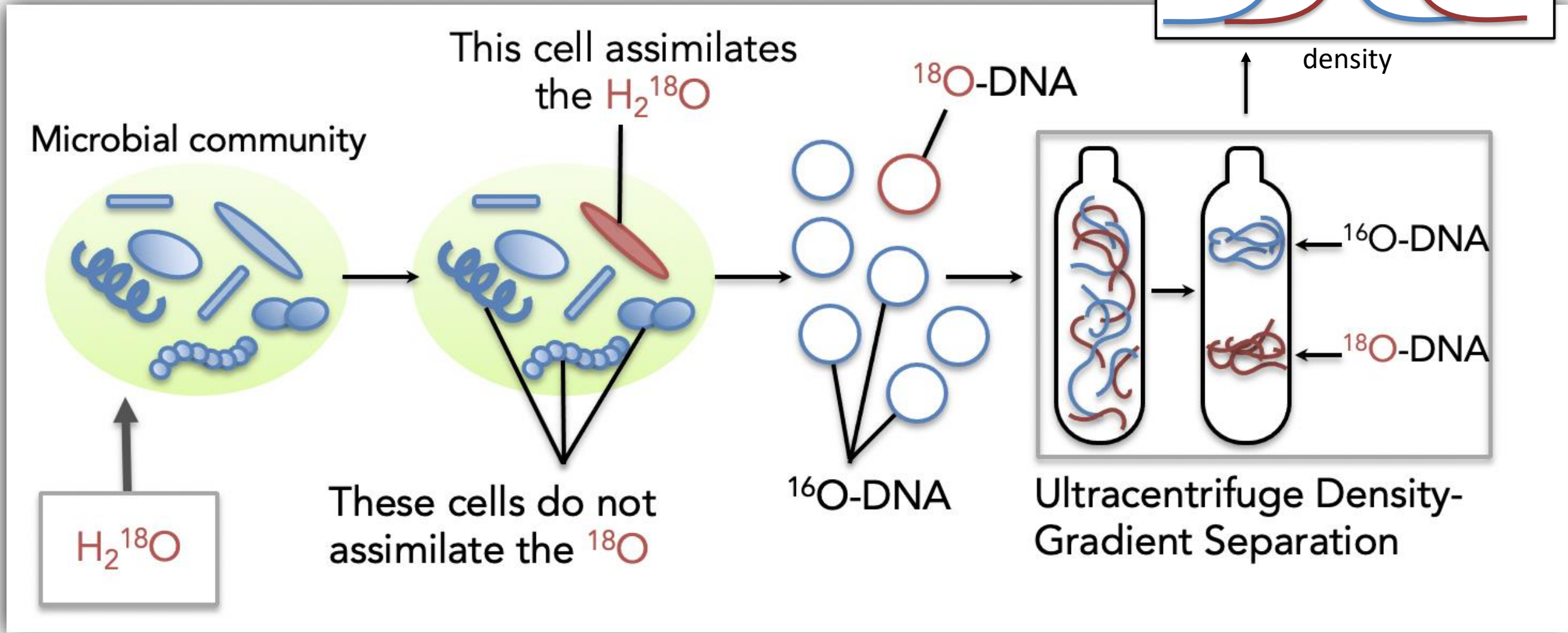
How do plant-associated fungi mediate microbial response to drought?

Moderate shift in microbial community structure following 12 weeks of water limitation with/without fungal inocula

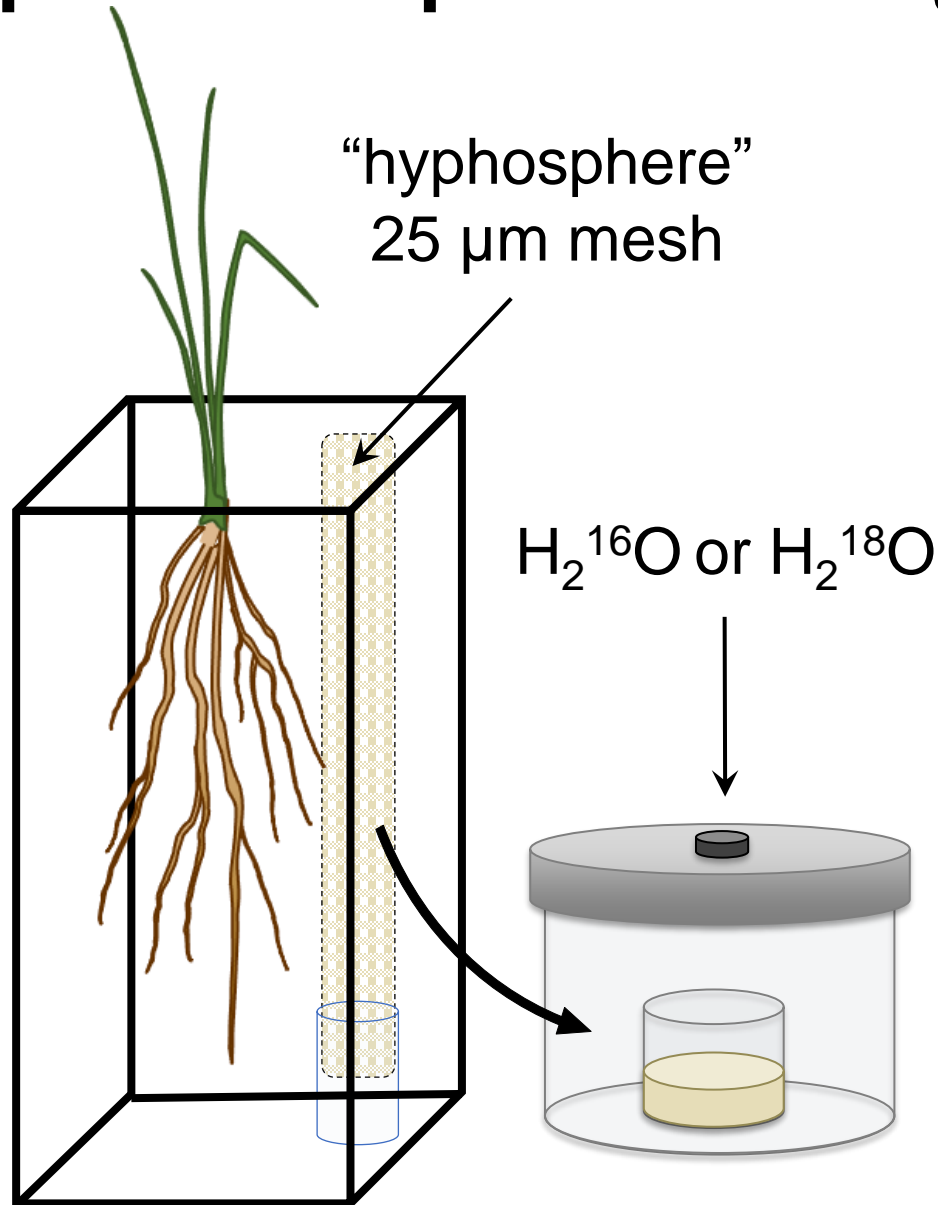
Traditional 16S rRNA gene profiling



DNA Stable Isotope Probing (SIP)



H₂¹⁸O DNA stable isotope probing can elucidate taxon-specific response to fungal inocula and soil moisture



Treatments

Fungi: Uninoculated, *R. irregularis*, *S. bescii*

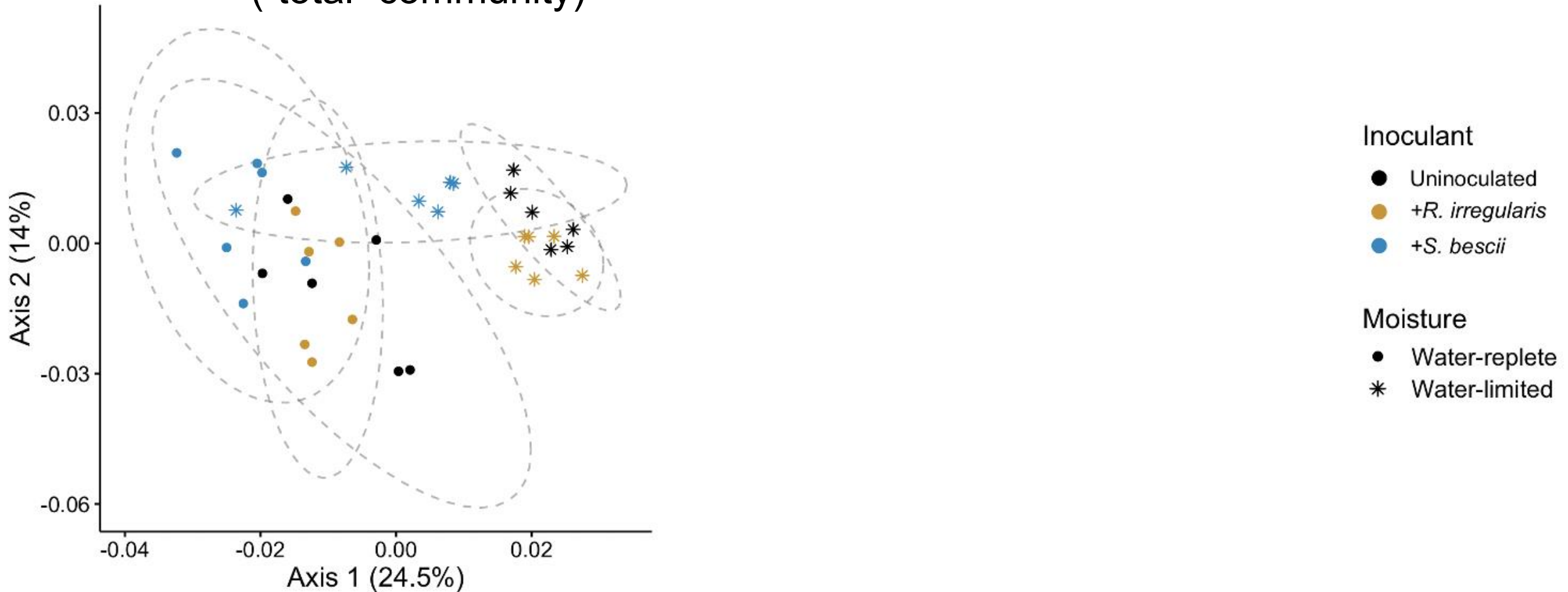
Moisture: Replete, Limited

O isotopes: H₂¹⁶O, H₂¹⁸O

Time: 0 to 7 days

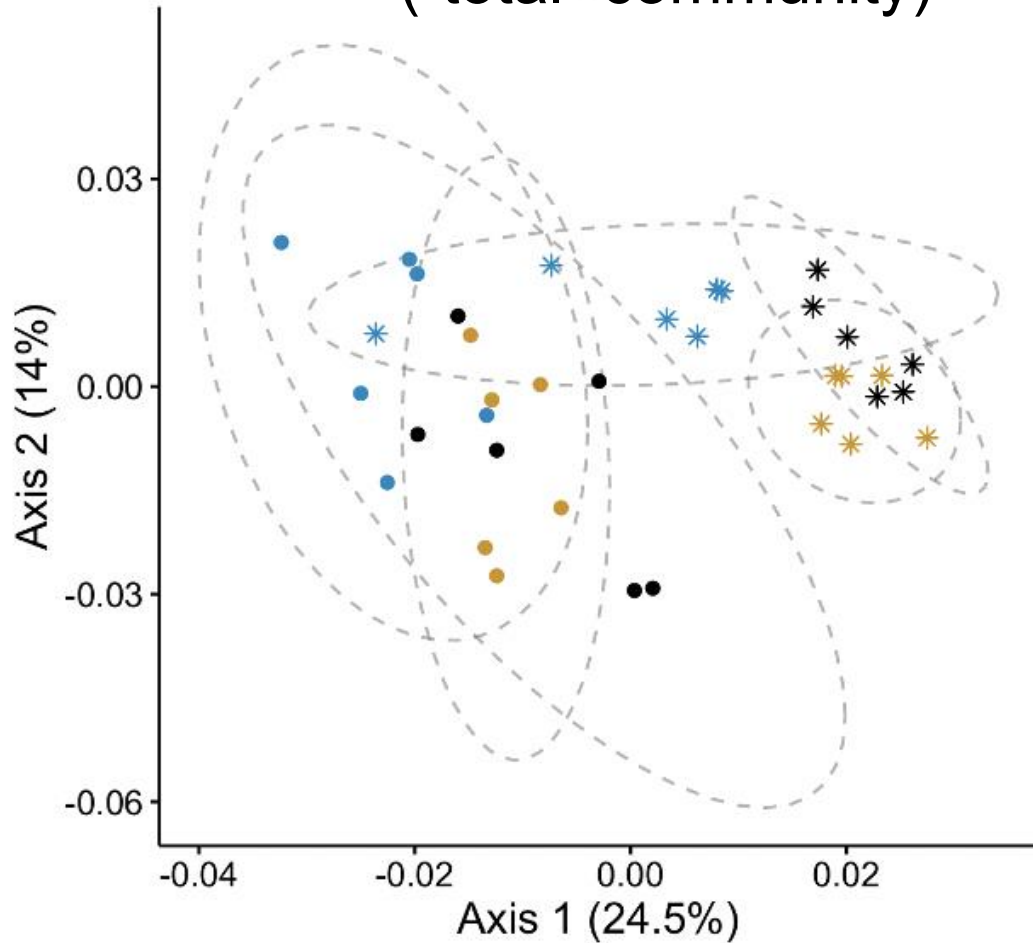
How do plant-associated fungi mediate microbial response to drought?

Traditional 16S rRNA gene profiling
("total" community)

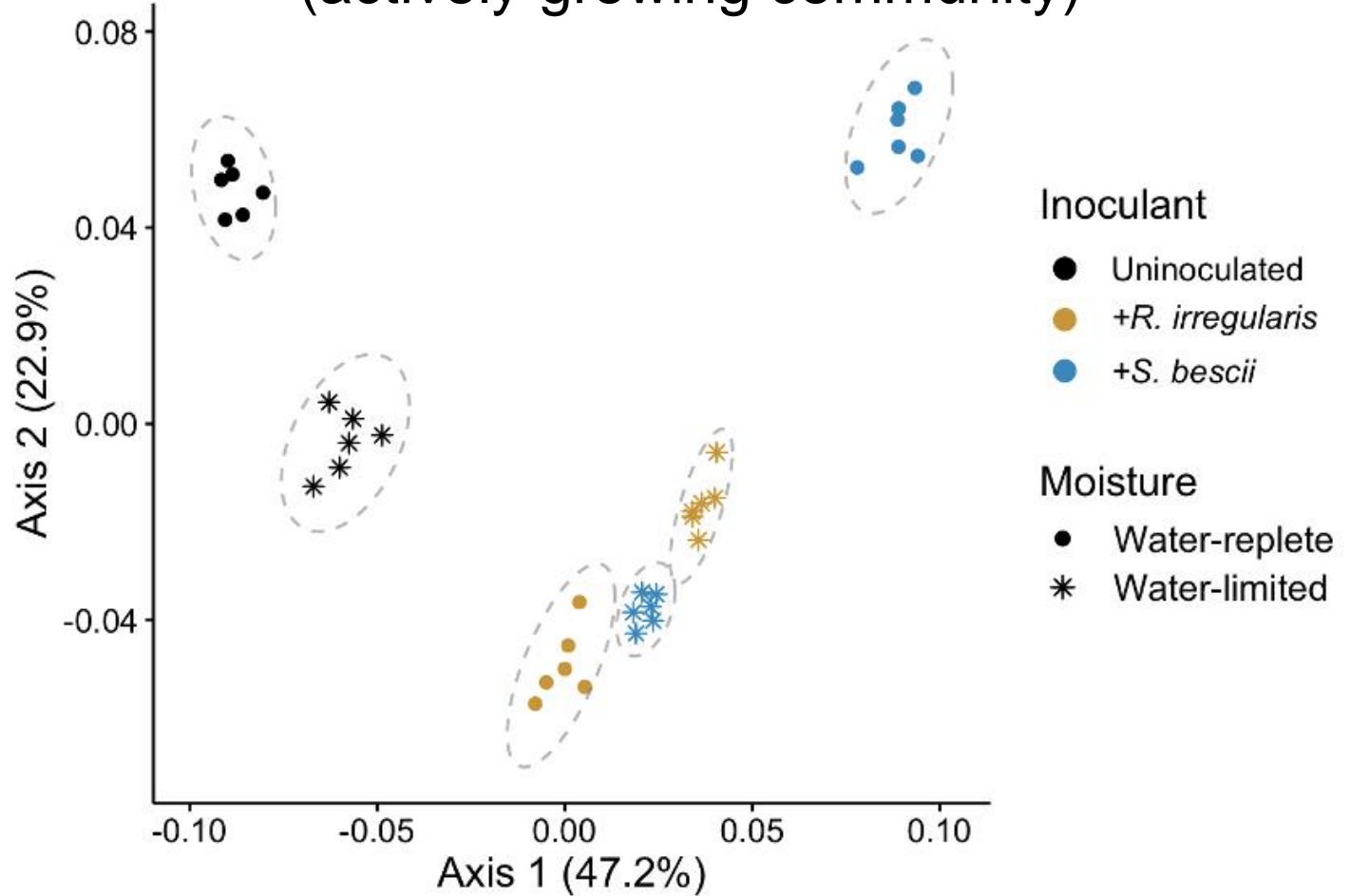


H₂¹⁸O DNA stable isotope probing elucidates fungal and moisture effects on bacterial community structure

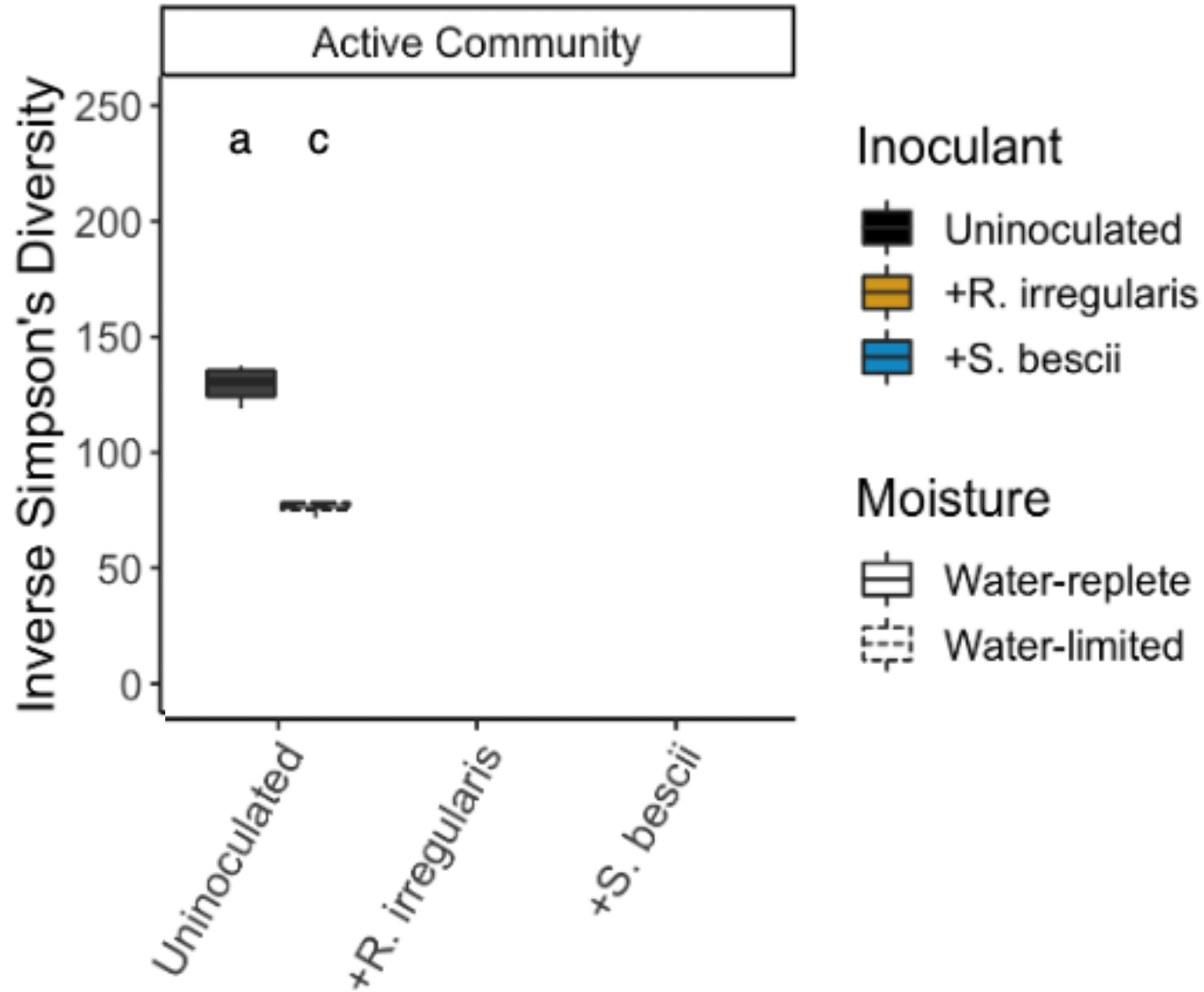
Traditional 16S rRNA gene profiling
("total" community)



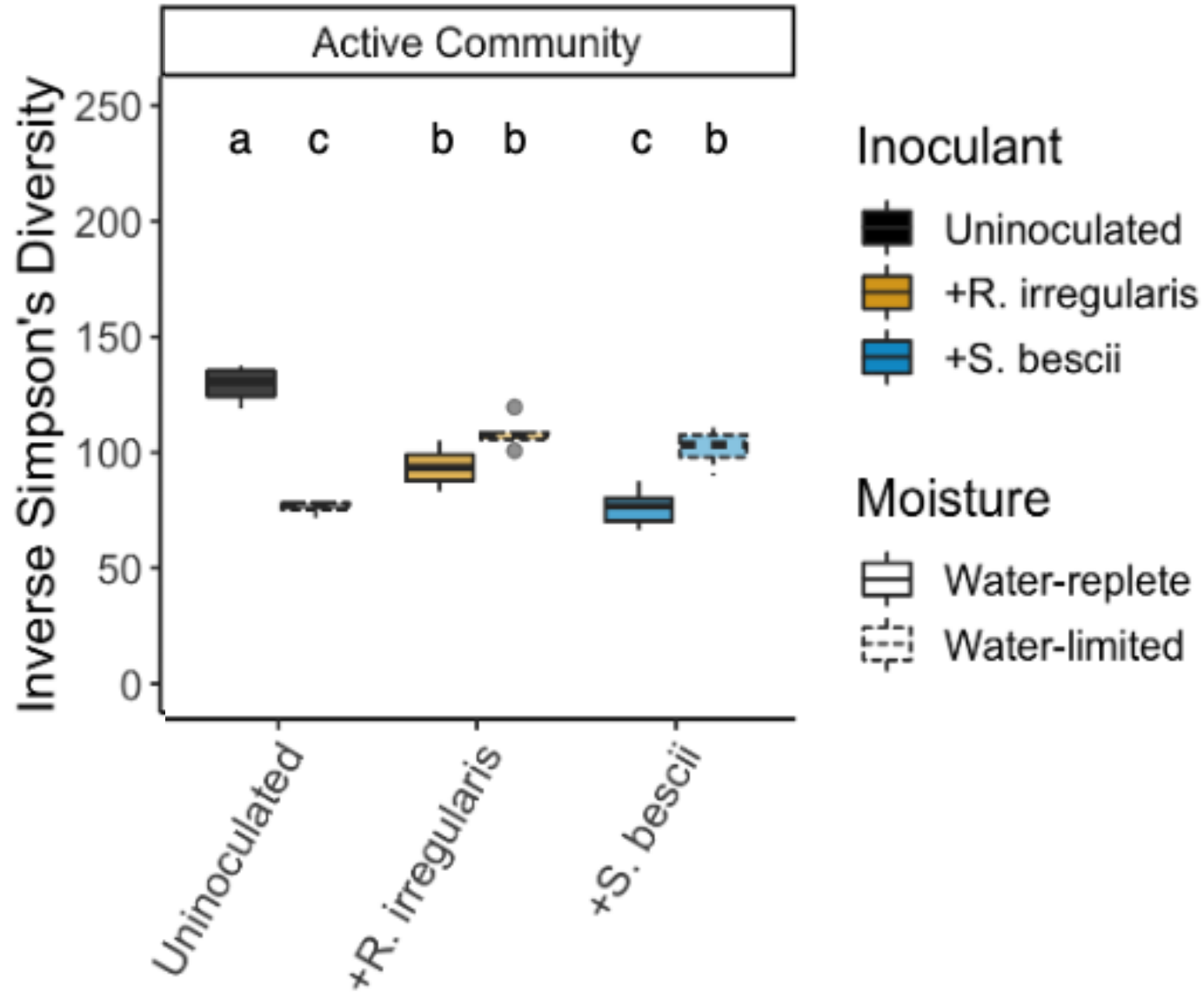
SIP-enabled 16S rRNA gene profiling
(actively growing community)



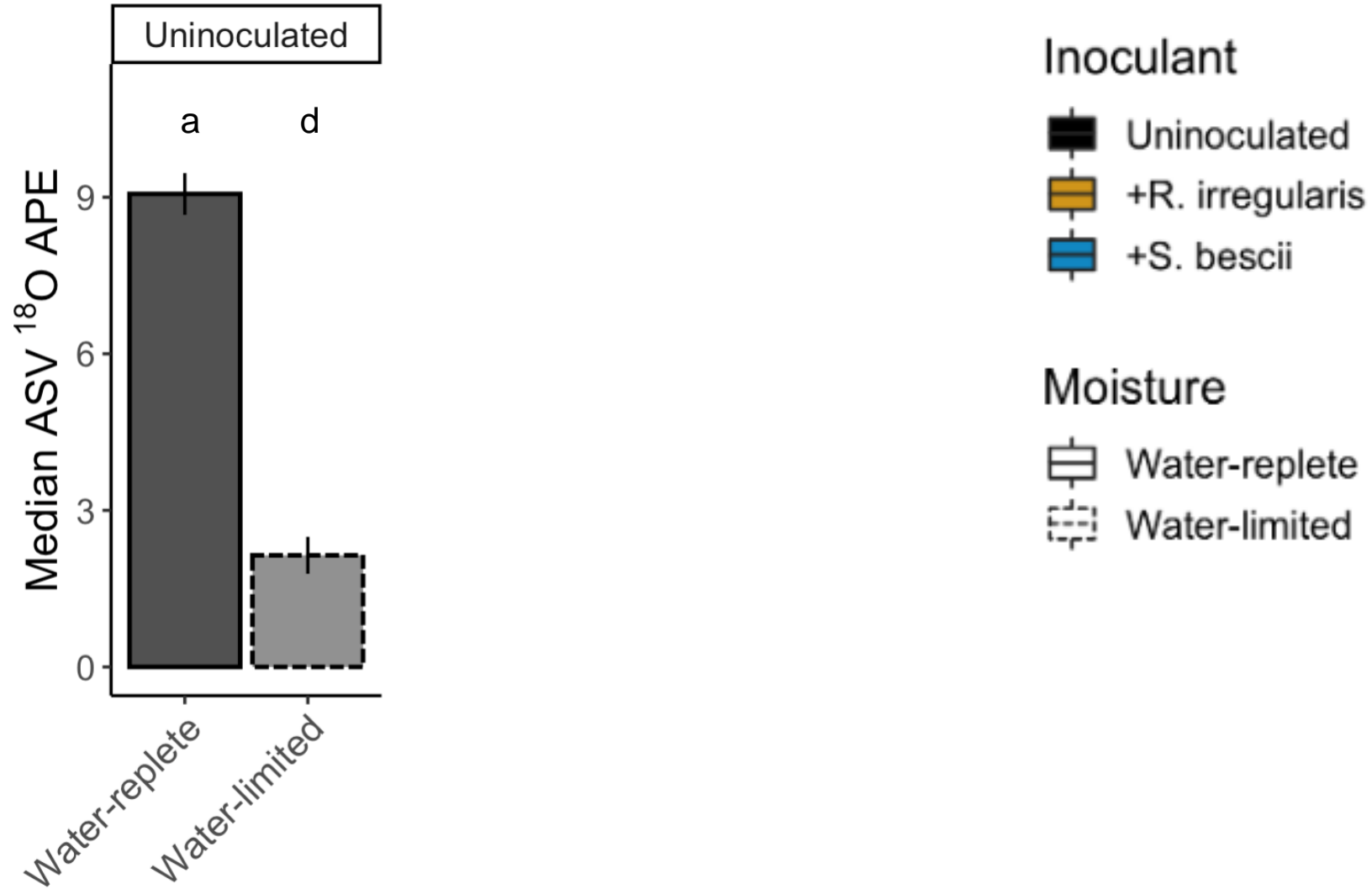
Diversity of actively growing community is lower in water-limited soil



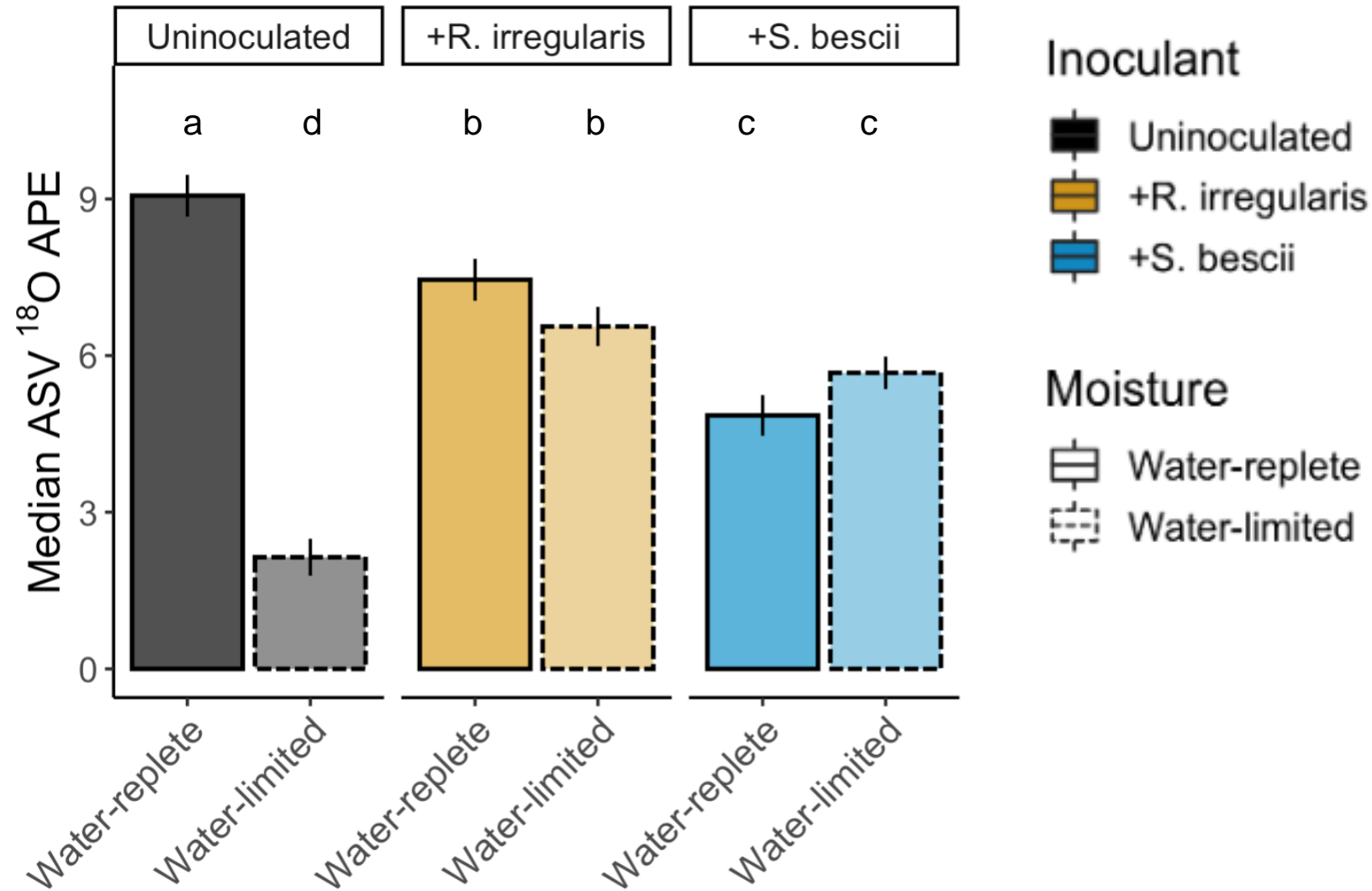
Plant-associated fungi help to maintain bacterial diversity in water-limited soils



Water limitation suppresses bacterial growth potential

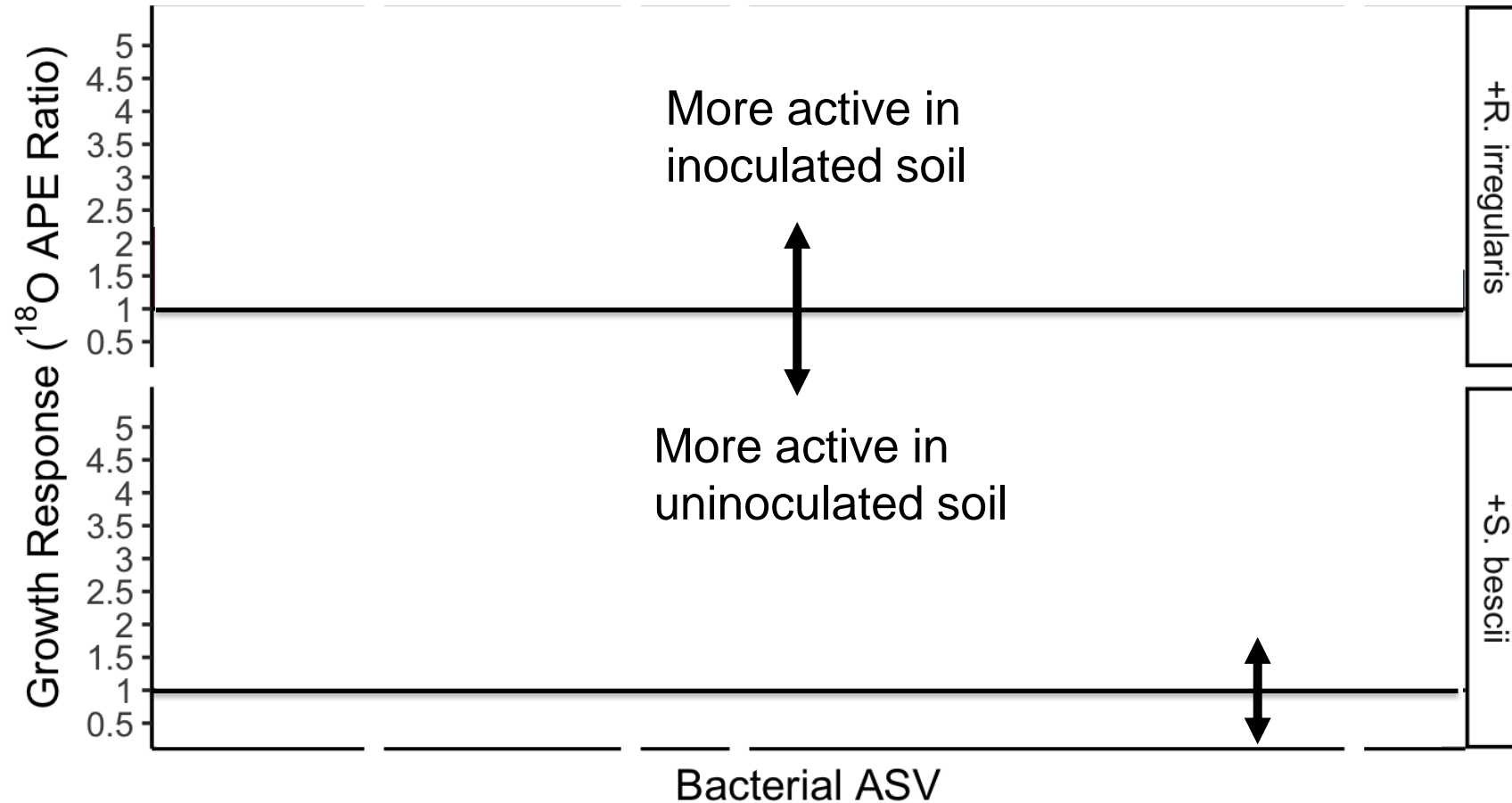


Plant-associated fungi support growth potential of bacteria exposed to water limitation



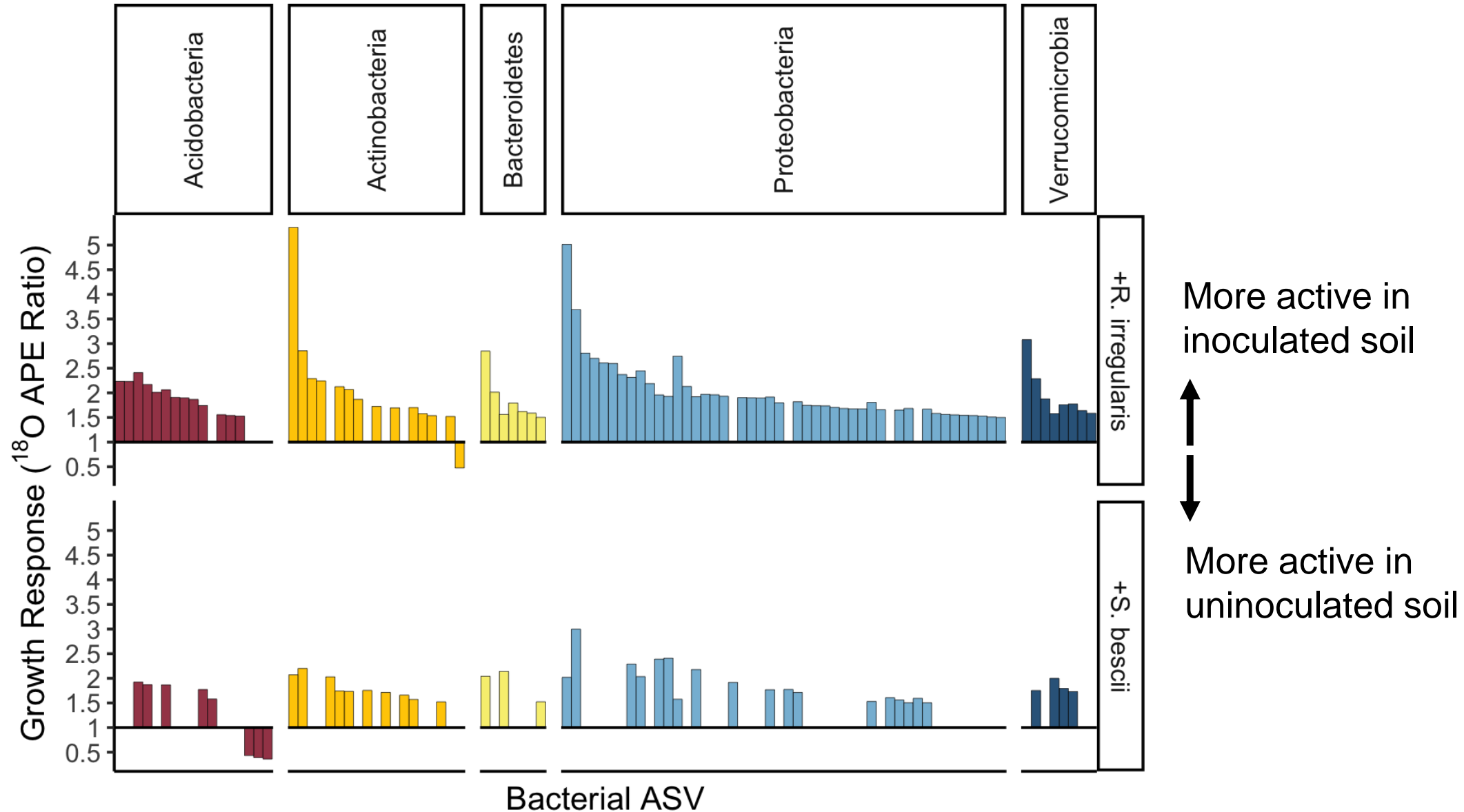
Which bacterial ASVs respond to plant-associated fungi in water-limited soils?

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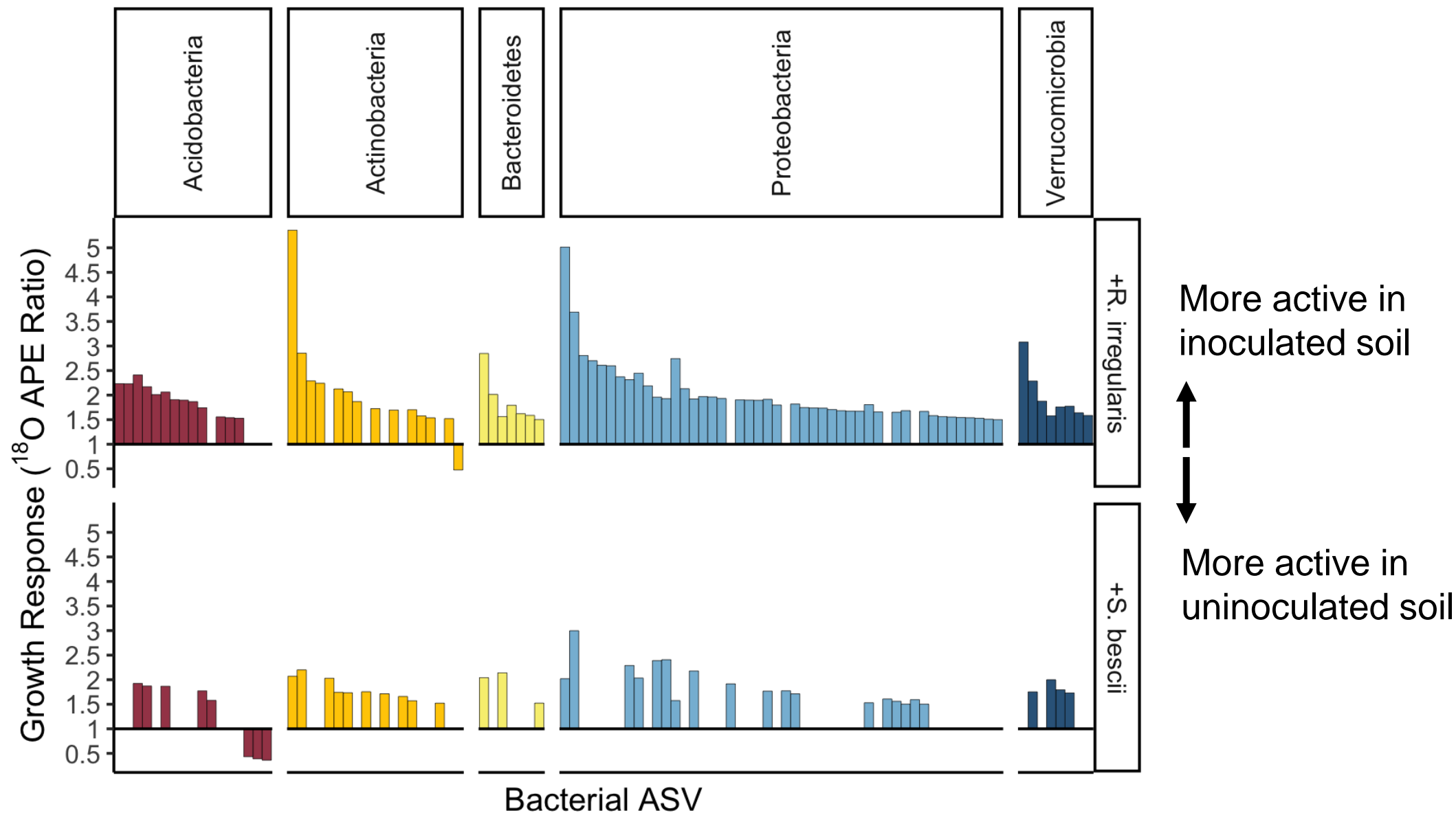


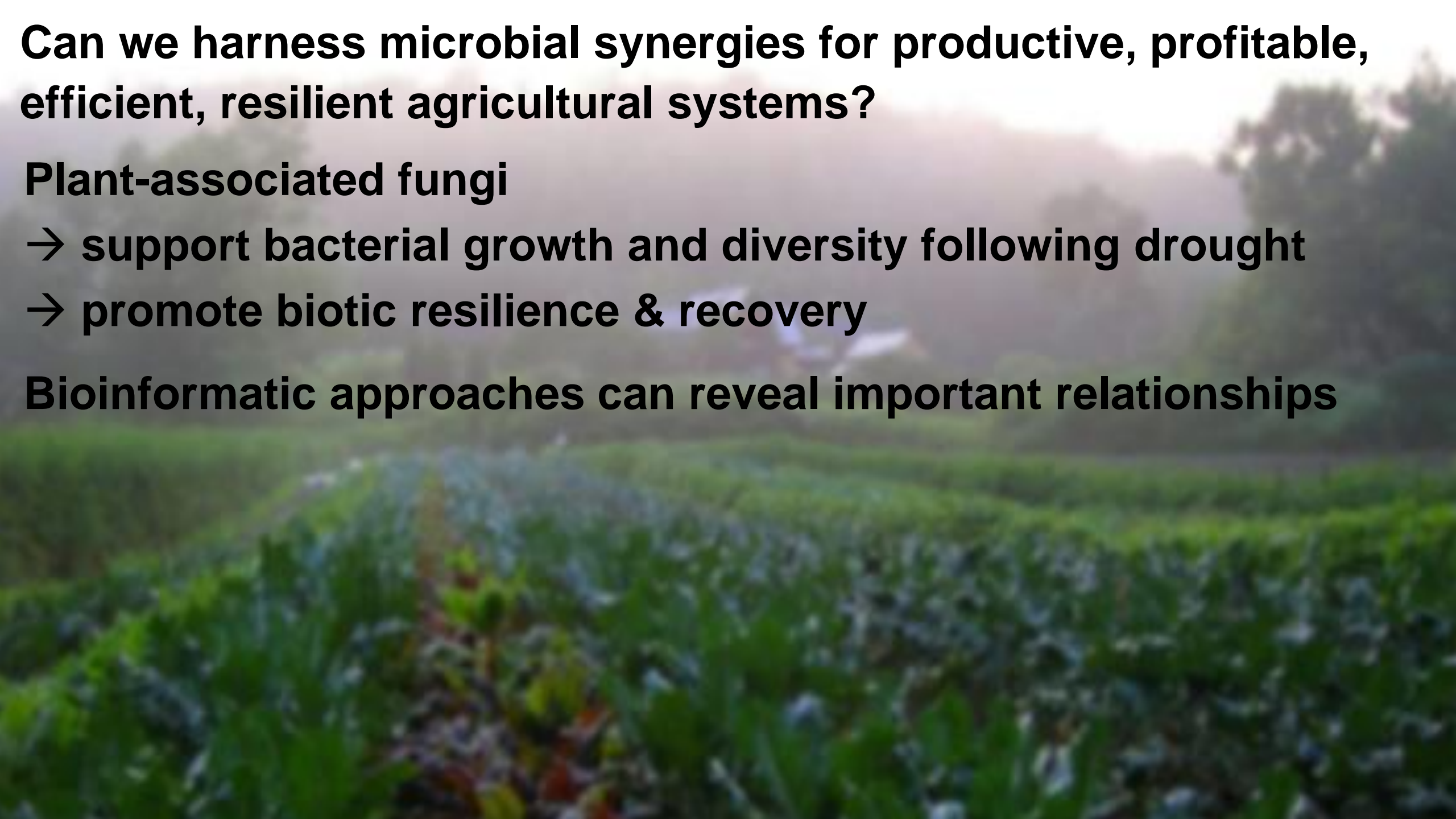
Most bacterial taxa respond positively to both fungi

Different fungi elicit distinct bacterial responses



Plant-associated fungi support 'drought-susceptible' bacterial taxa in water-limited soil





Can we harness microbial synergies for productive, profitable, efficient, resilient agricultural systems?

Plant-associated fungi

- support bacterial growth and diversity following drought**
- promote biotic resilience & recovery**

Bioinformatic approaches can reveal important relationships

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