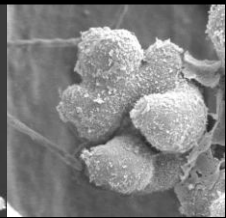
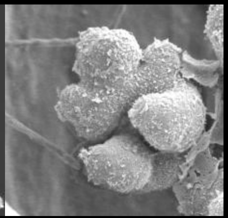



Arbuscular mycorrhizal interactions – an important trait for biomass production of bioenergy crops?

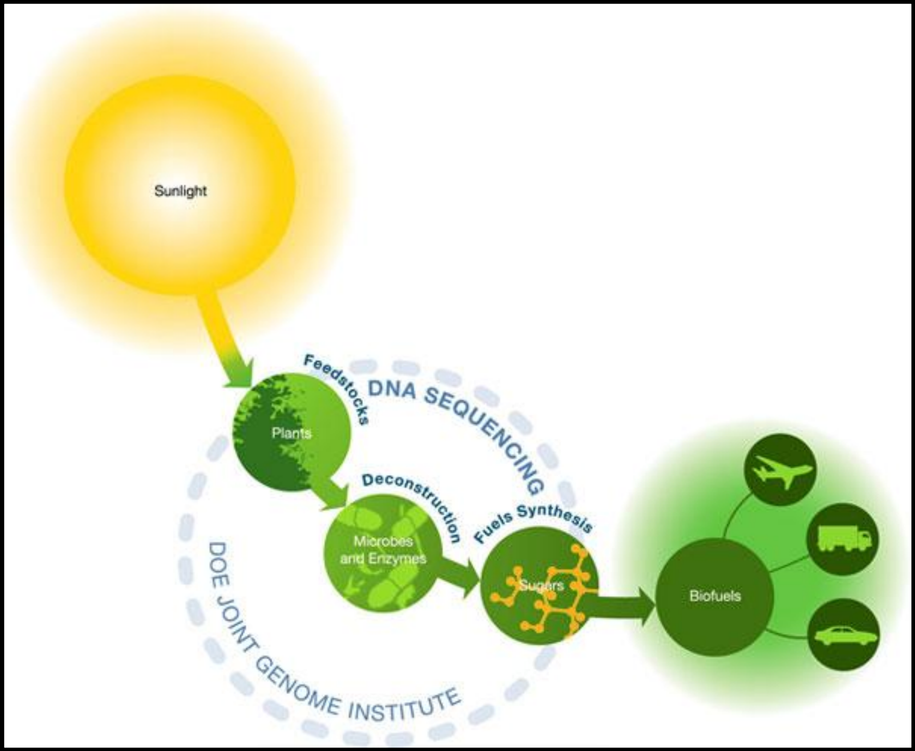
Heike Bücking

Symbiosis Conference, Cornell University

June 20, 2013



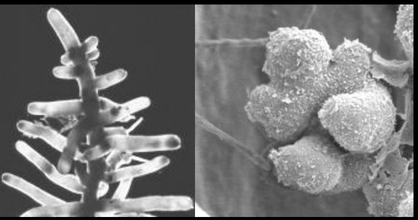
Characteristics of an ‚ideal‘ bioenergy crop



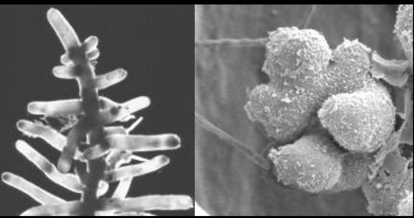
JGI DOE

1. C4 photosynthesis
2. Long canopy duration
3. Capability to recycle nutrients
4. High water acquisition and use efficiency
5. Non-invasive
6. High pathogen and pest resistance
7. Clean burning

Majority of these characteristics is affected by beneficial plant-microbe interactions, and here particularly by arbuscular mycorrhizal interactions



Why prairie cordgrass?



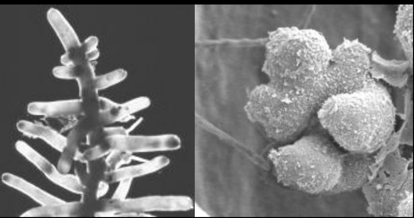
Why prairie cordgrass?

Prairie cordgrass **Switchgrass**

- ❑ Native perennial grass
- ❑ High biomass production
- ❑ Suitable for growth on marginal lands
- ❑ Salt tolerant
- ❑ Large carbon sequestration capacity
- ❑ Recycling of nutrients
- ❑ Early spring growth

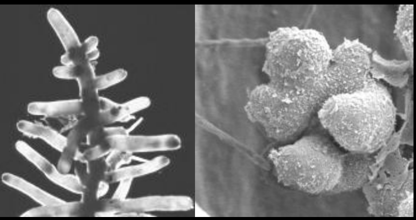
↓

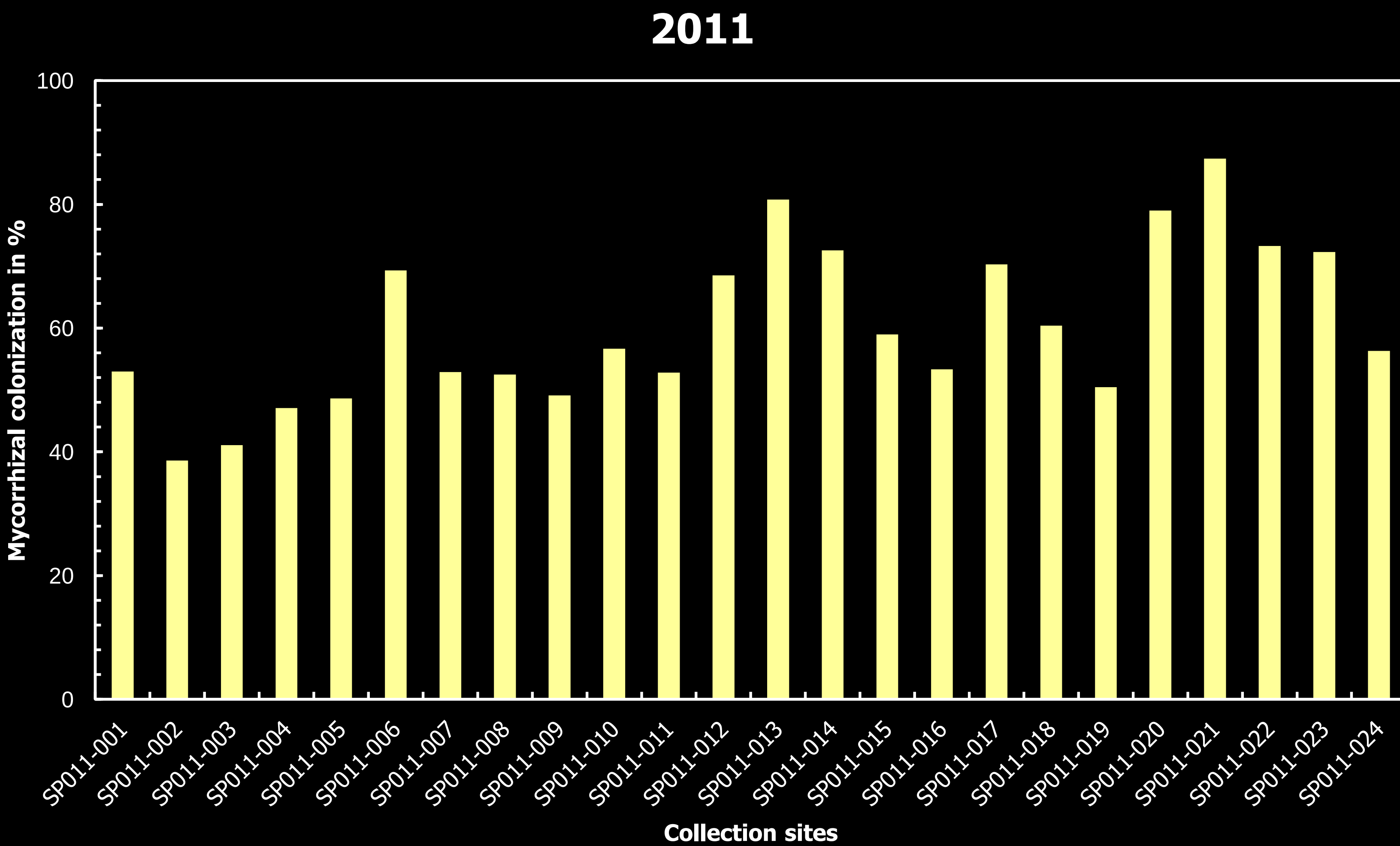
High genetic diversity and lack of genome/transcriptome resources hinders molecular breeding

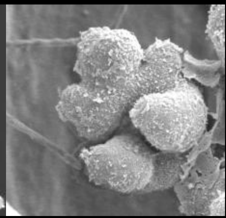


What is the AM community composition of prairie cordgrass?

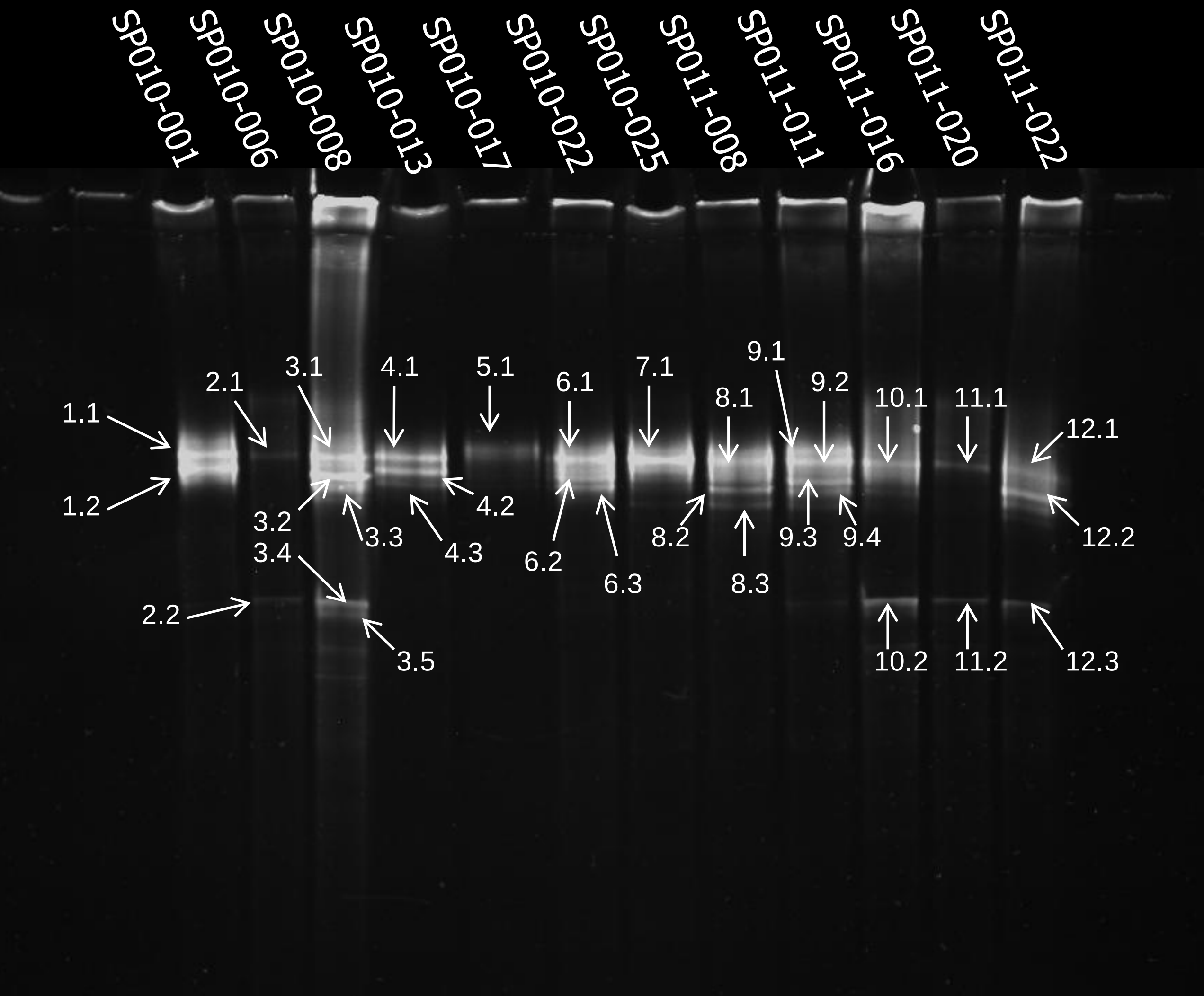
Mycorrhizal communities of prairie cordgrass





Mycorrhizal communities of prairie cordgrass



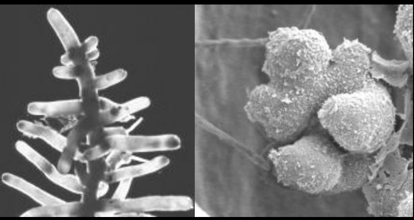
Glomus intraradices, Glomus irregulare, Rhizophagus irregulare
1.1; 2.1; 3.1; 4.1; 6.1; 8.1; 9.2; 10.1; 12.1
2.2; 3.4; 10.2; 11.2

Glomus iranicum
3.2; 3.3; 3.4; 3.5; 4.2; 4.3; 6.2; 6.3, 9.3, 9.4; 12.2; 12.3

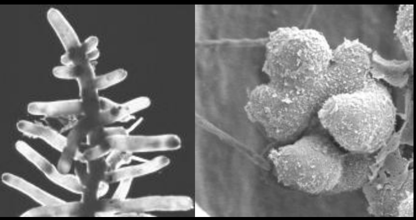
Glomus fasciculatum
11.1

Glomus hoi, Glomus macrocarpum
9.1

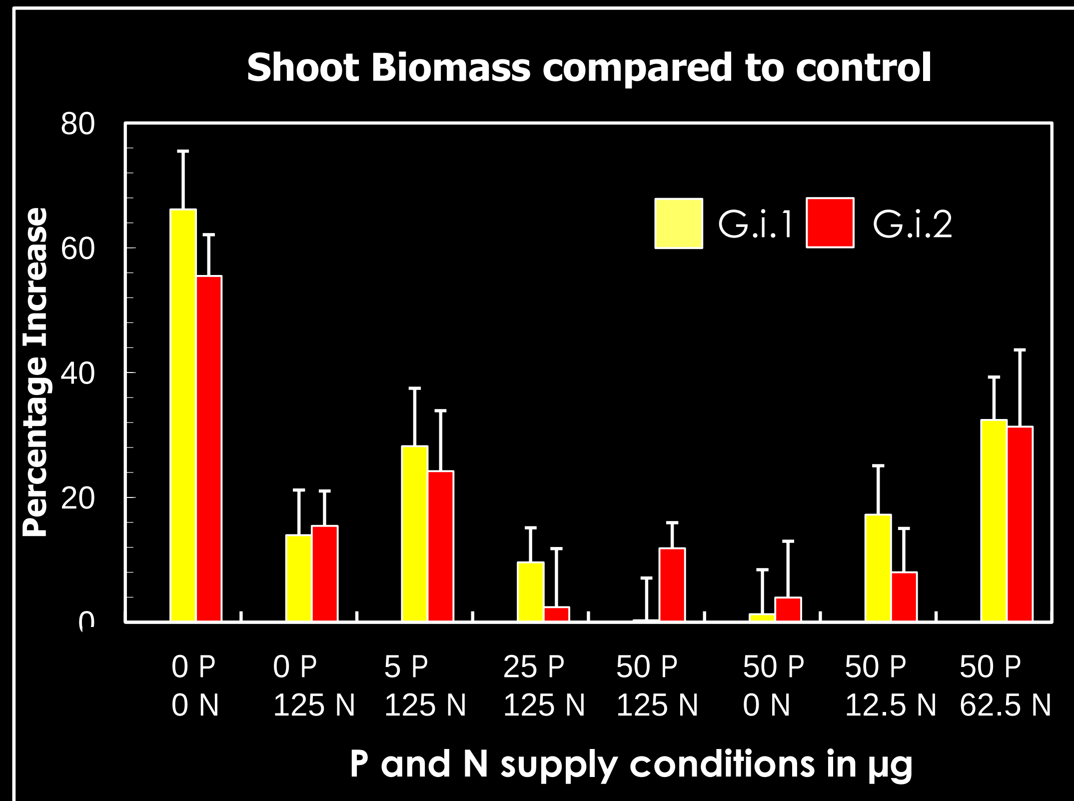
Unidentified AM fungus
5.1; 1.2; 8.2; 8.3;



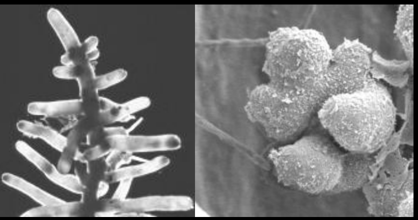
What is the effect of arbuscular mycorrhizal communities on biomass development in prairie cordgrass?

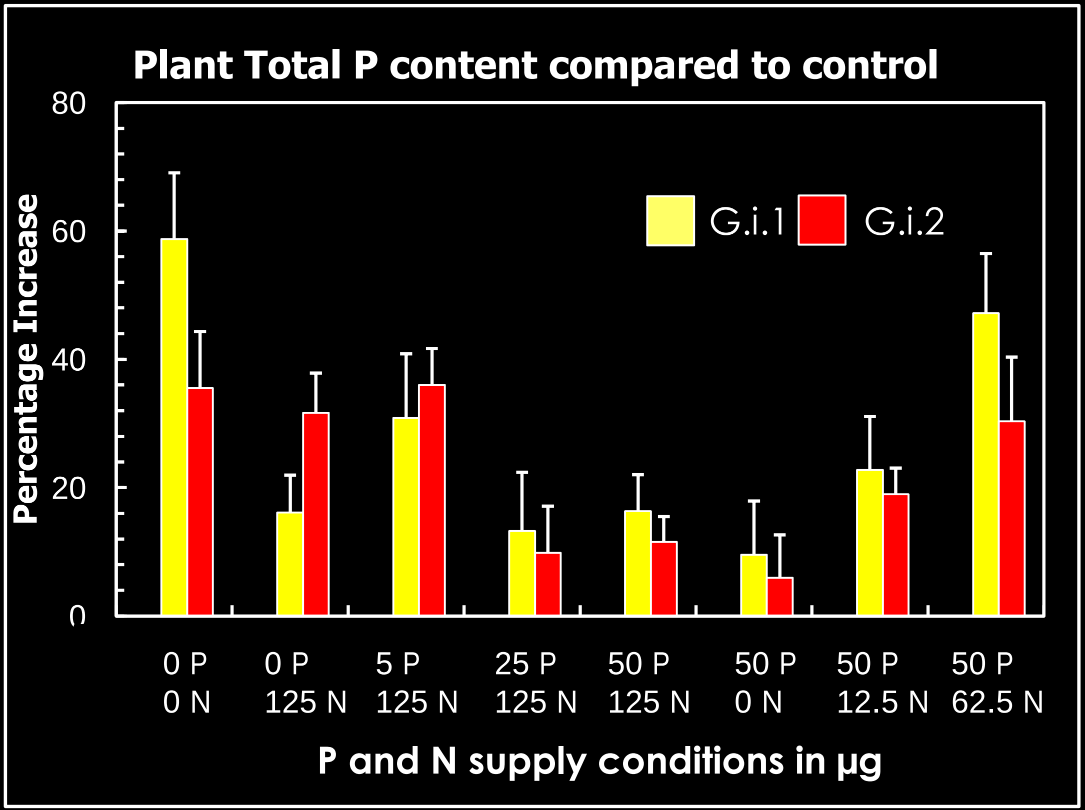


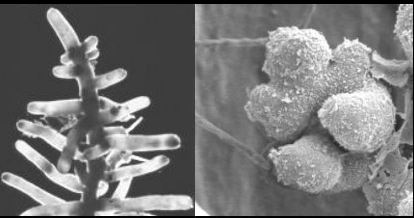
Mycorrhizal responsiveness



Mycorrhizal responsiveness

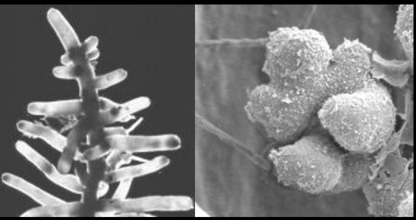






How does fungal diversity affect

plant benefit?



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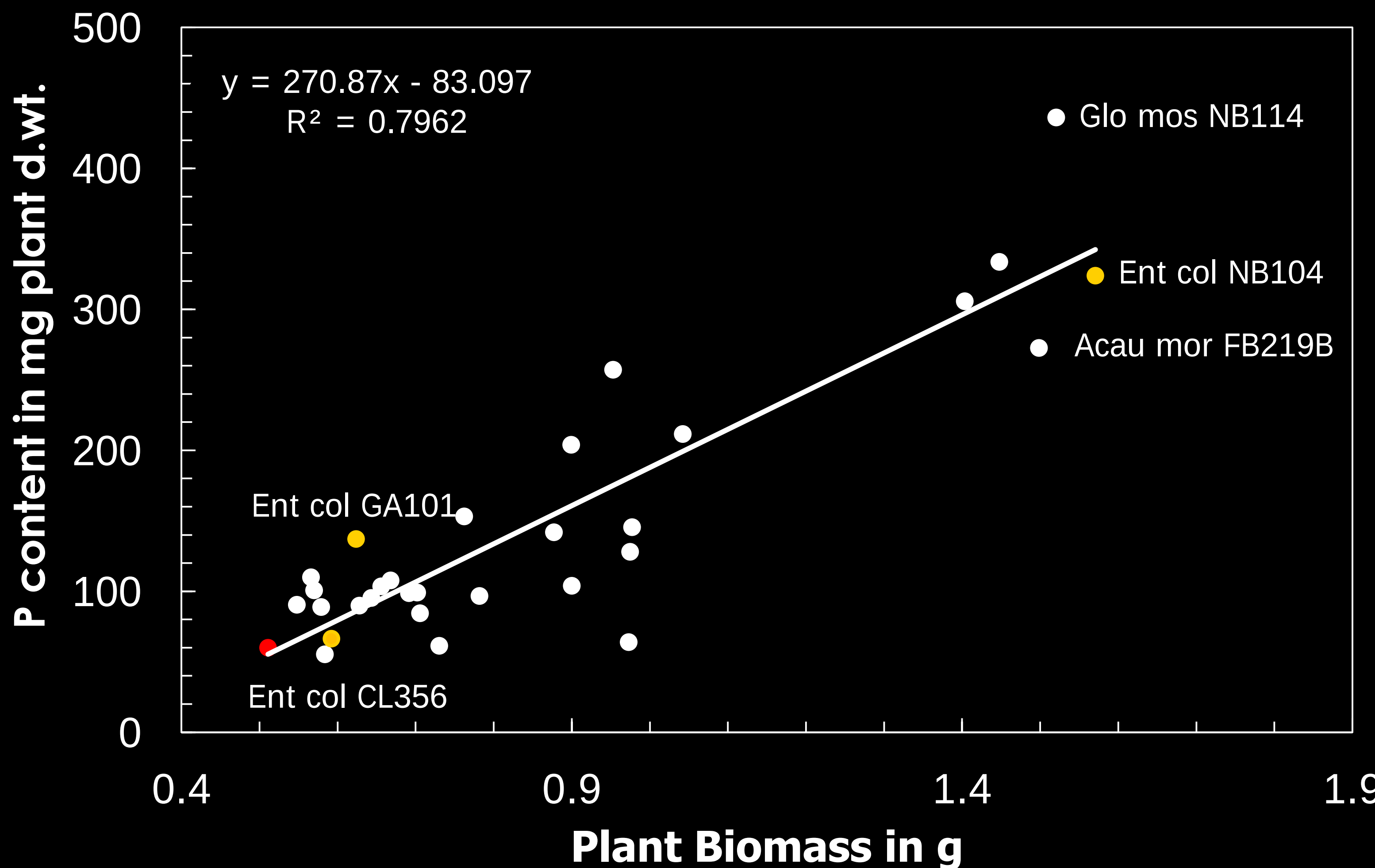
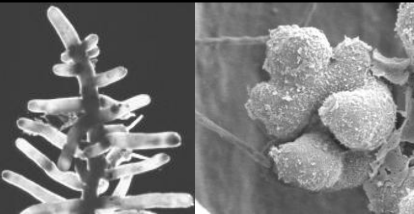
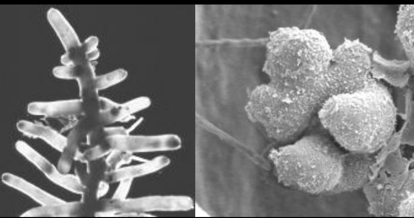


Mensah, Koch, Bücking, unpublished



How does plant diversity affect plant benefit?



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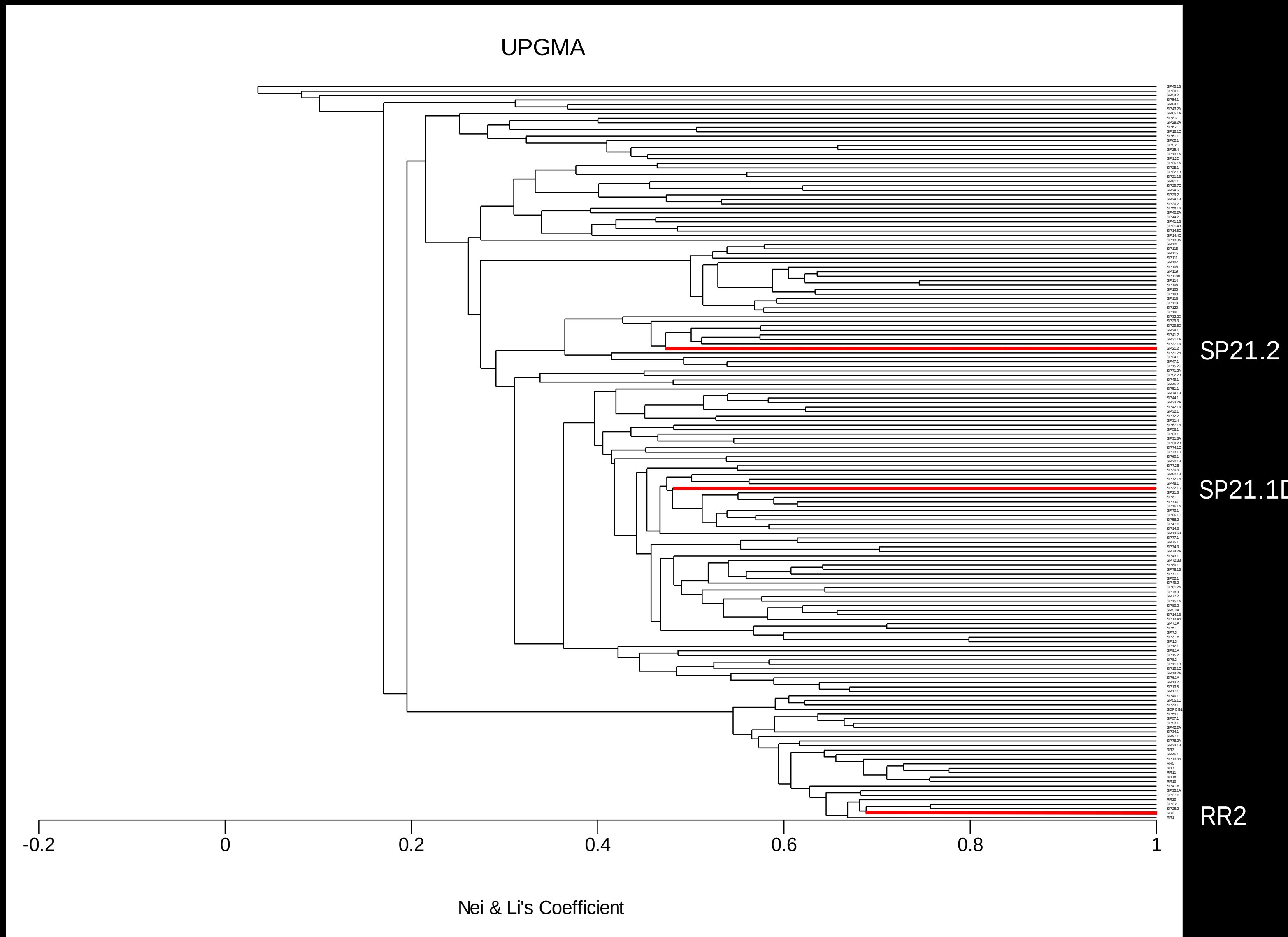
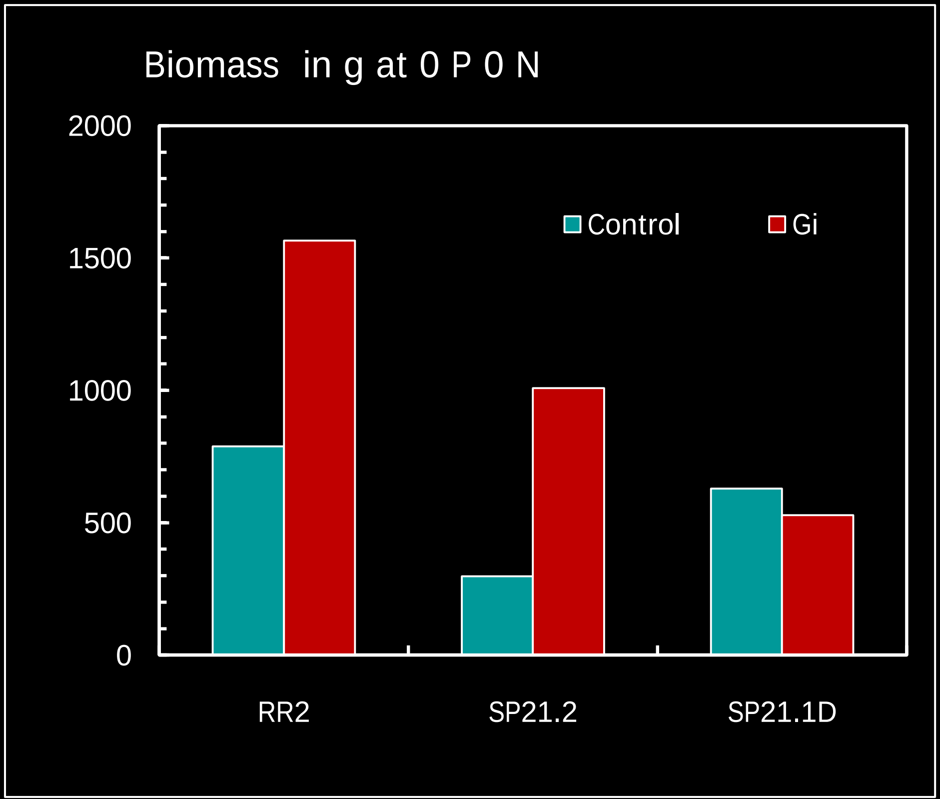
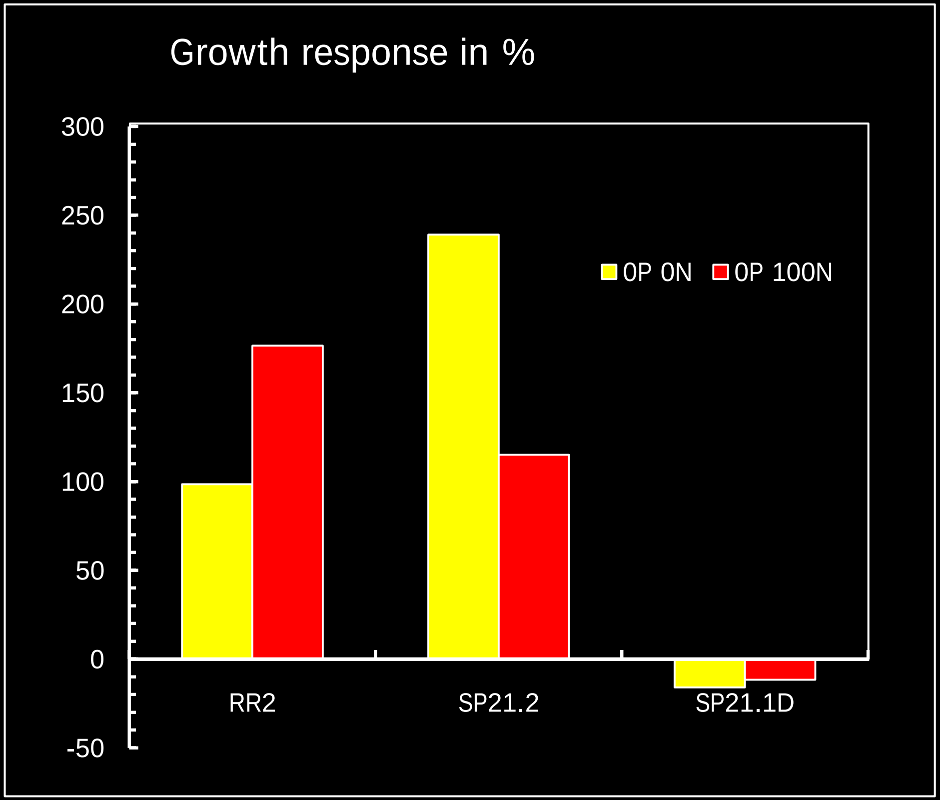
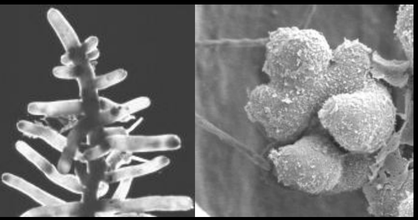


Genotypic differences in mycorrhizal responsiveness



Genotypic differences in mycorrhizal responsiveness





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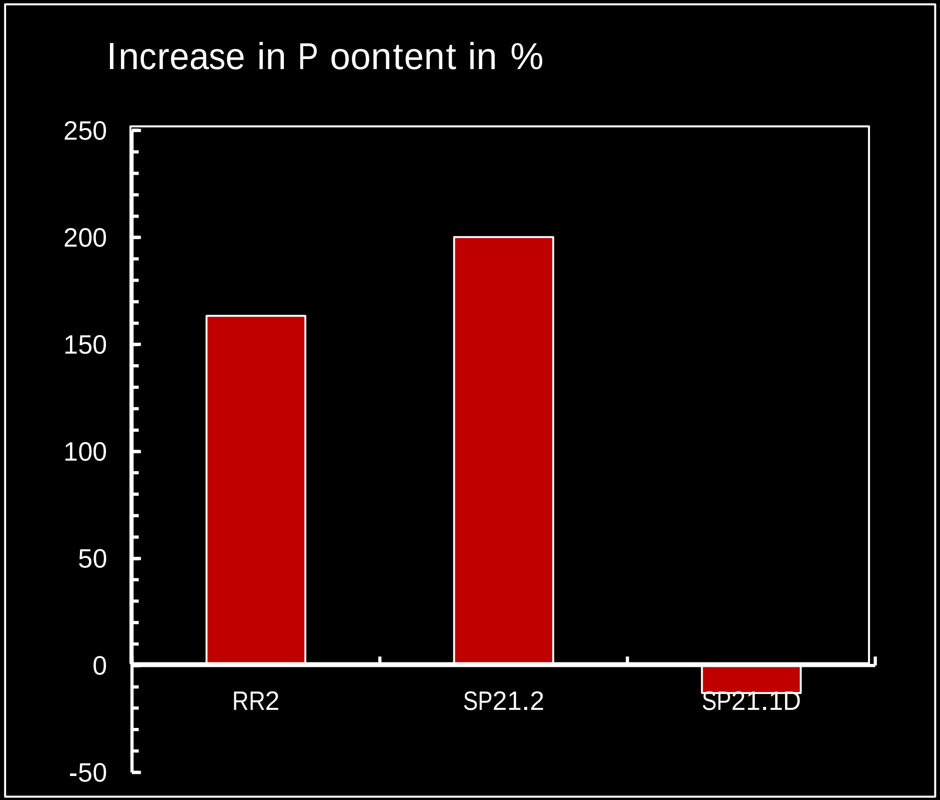
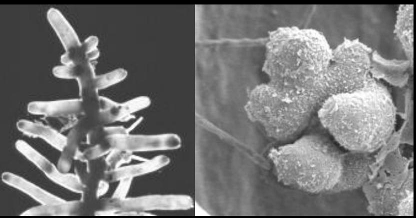
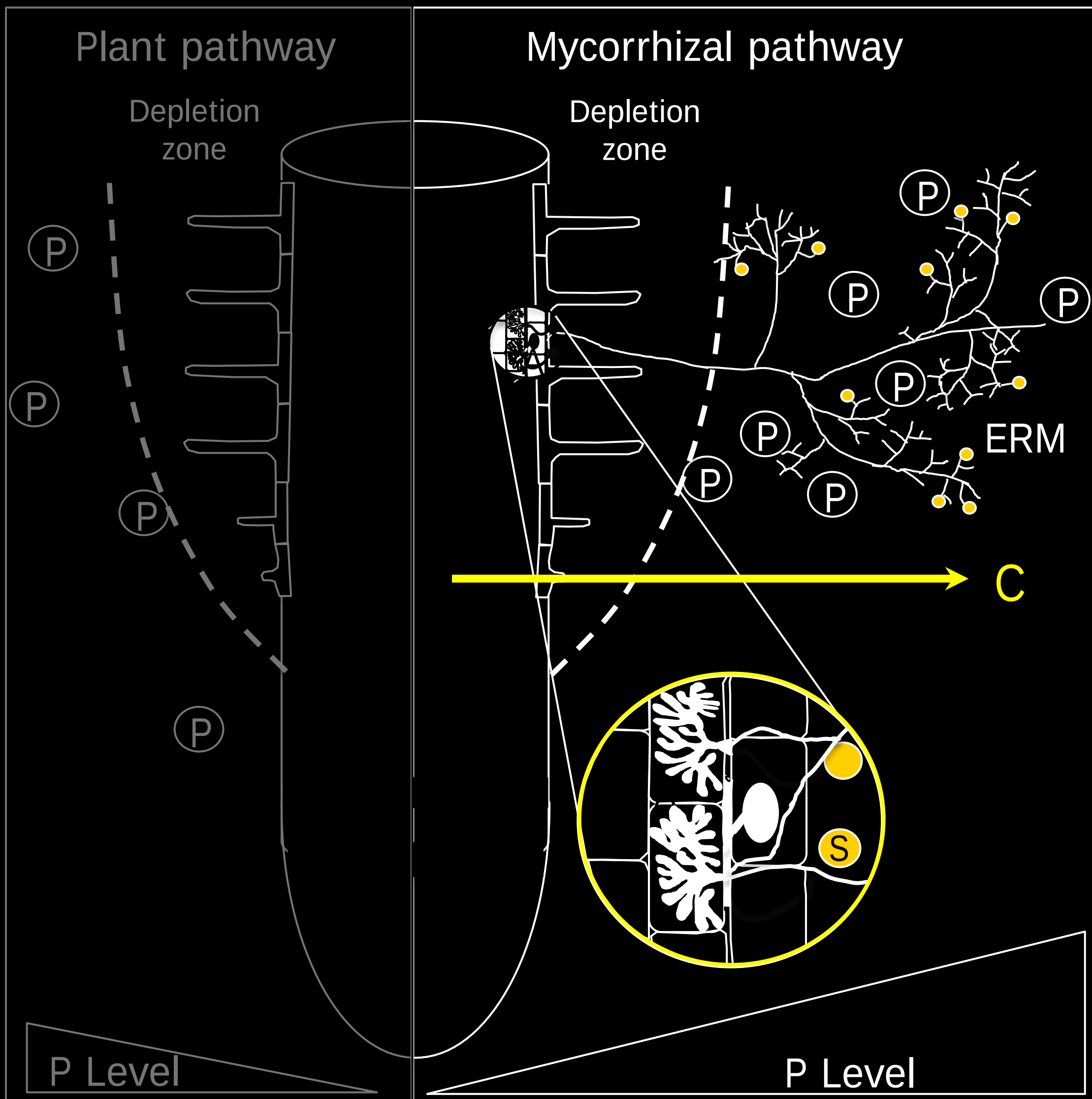
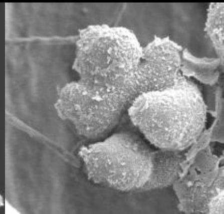




Potential reasons for differences in nutrient efficieny

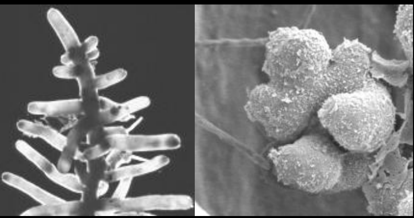


- Carbon costs of the symbiosis for the host
- Reduction in plant P uptake that is not compensated for by AM fungal P uptake
- Inefficient nutrient exchange across the mycorrhizal interface

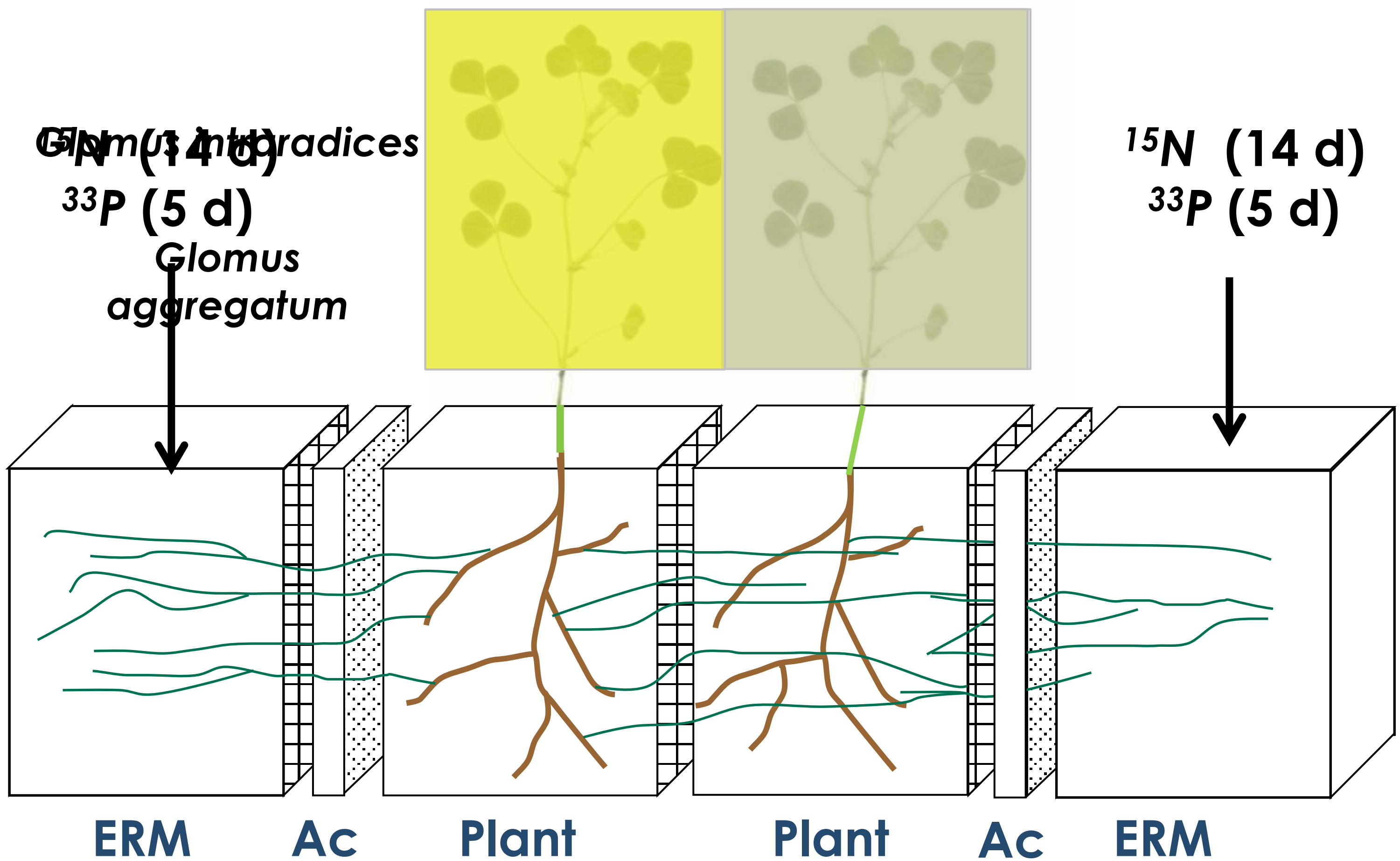



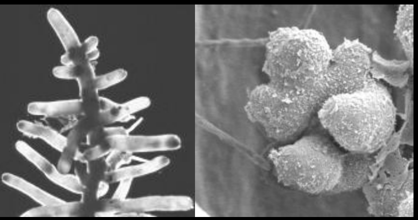
How does resource exchange

affect plant benefit?

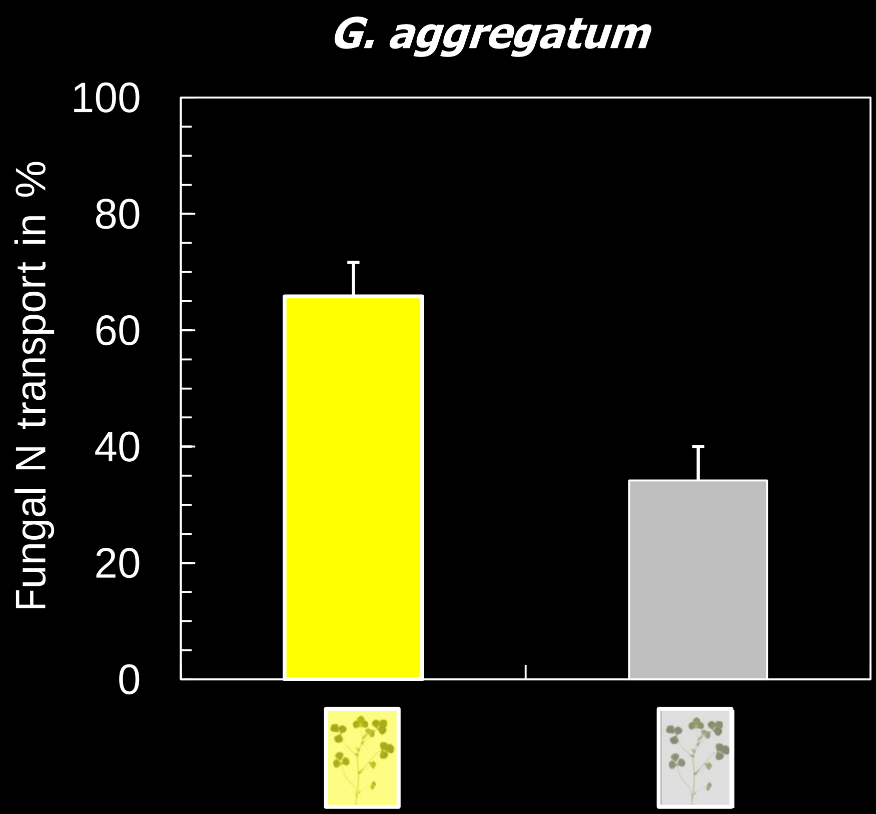


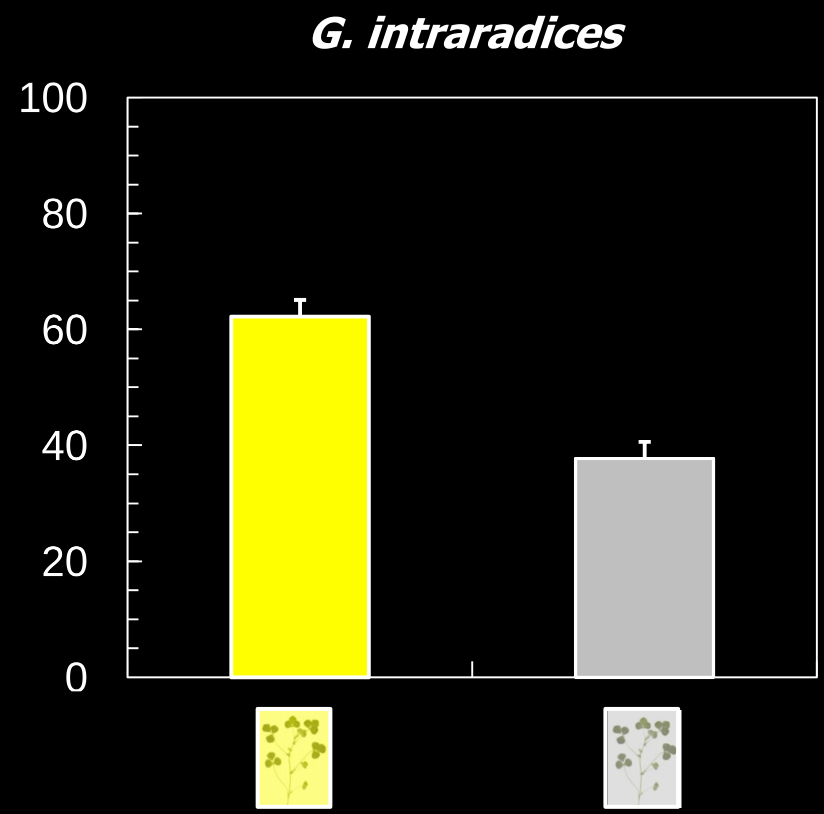
Experimental Design

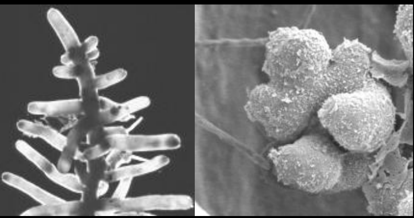




Host photosynthesis affects fungal N transport in CMN







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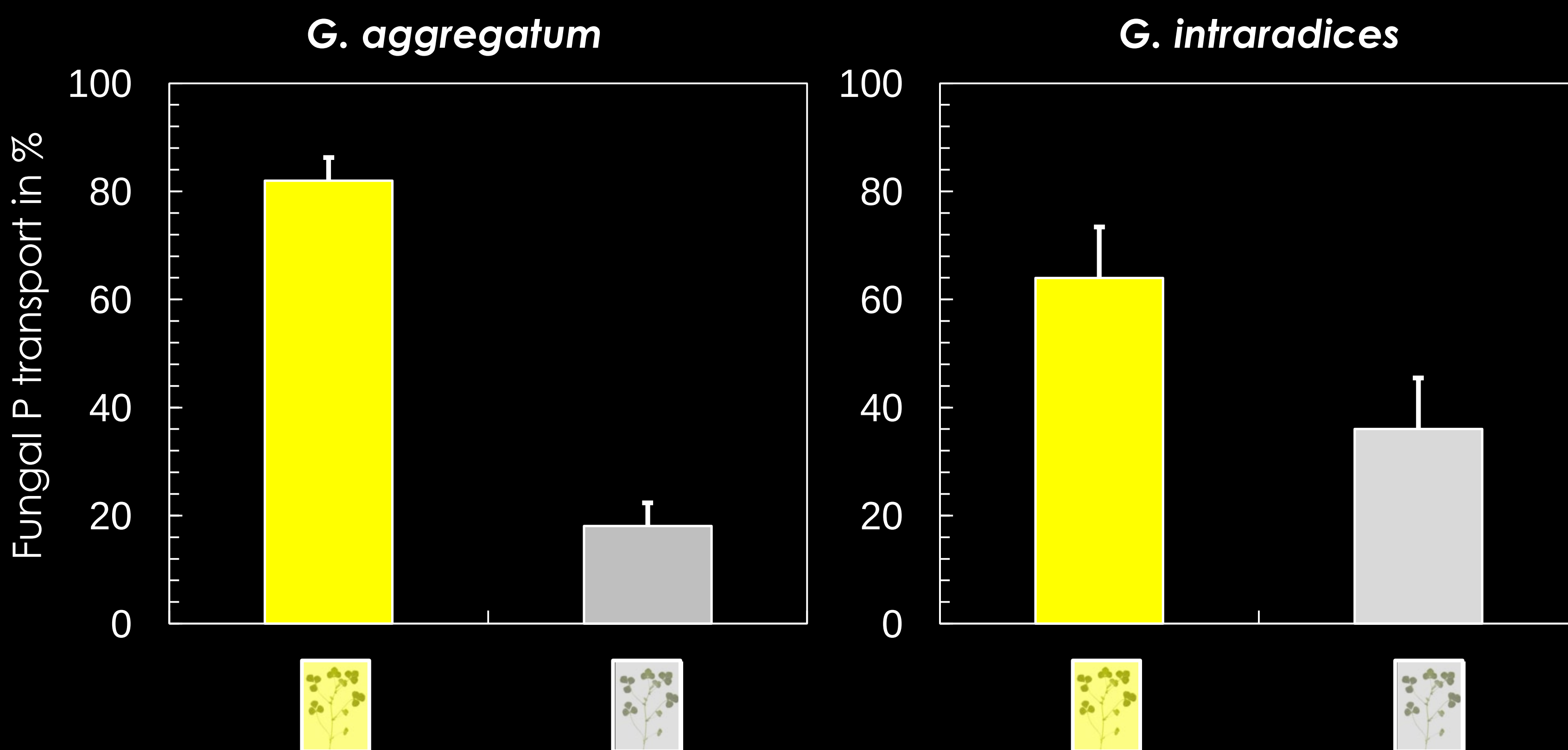
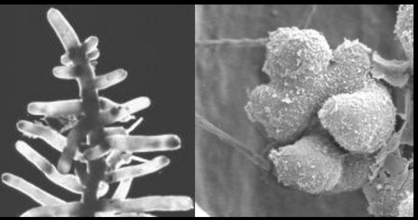
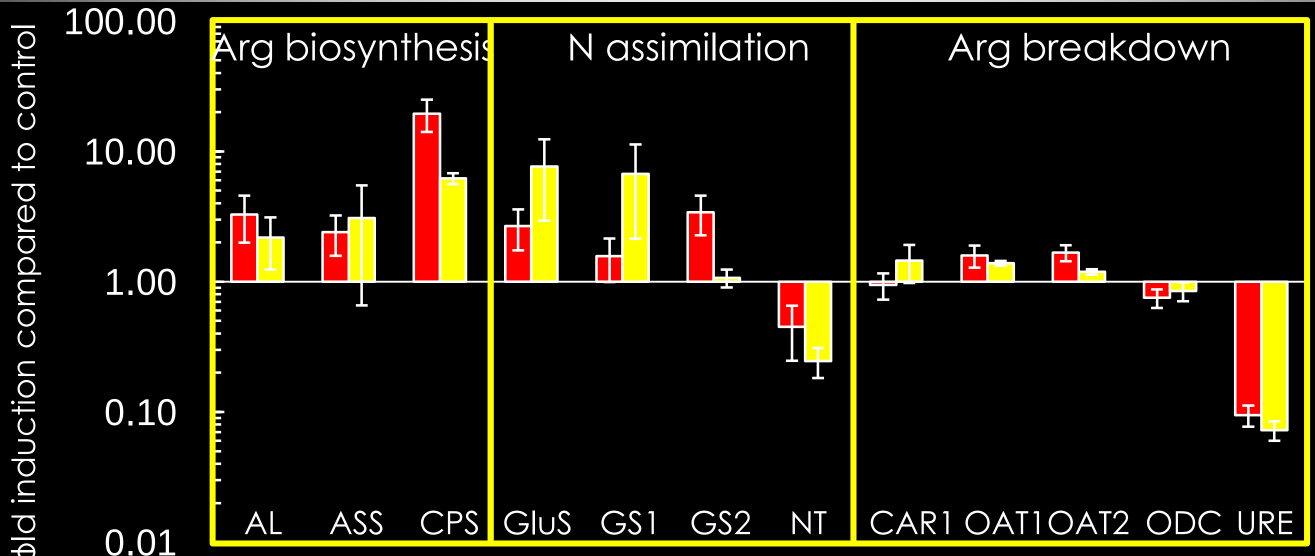
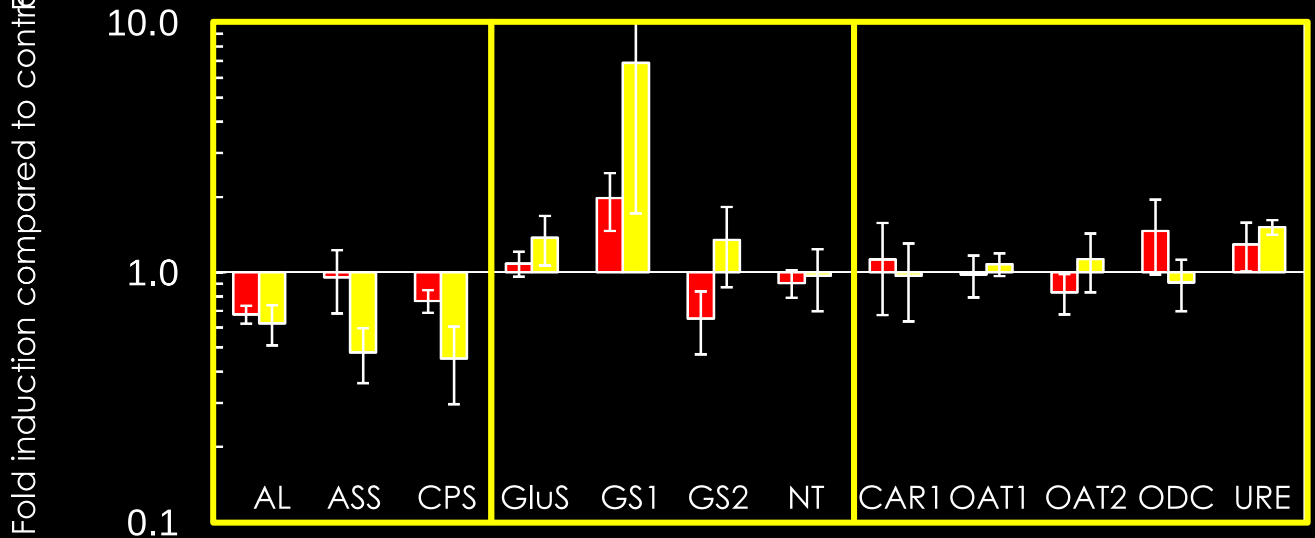




Carbon acts as trigger for N uptake and transport

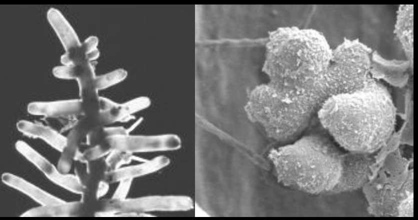


ERM



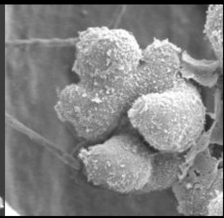
IRM

Fellbaum et al., PNAS, 2012

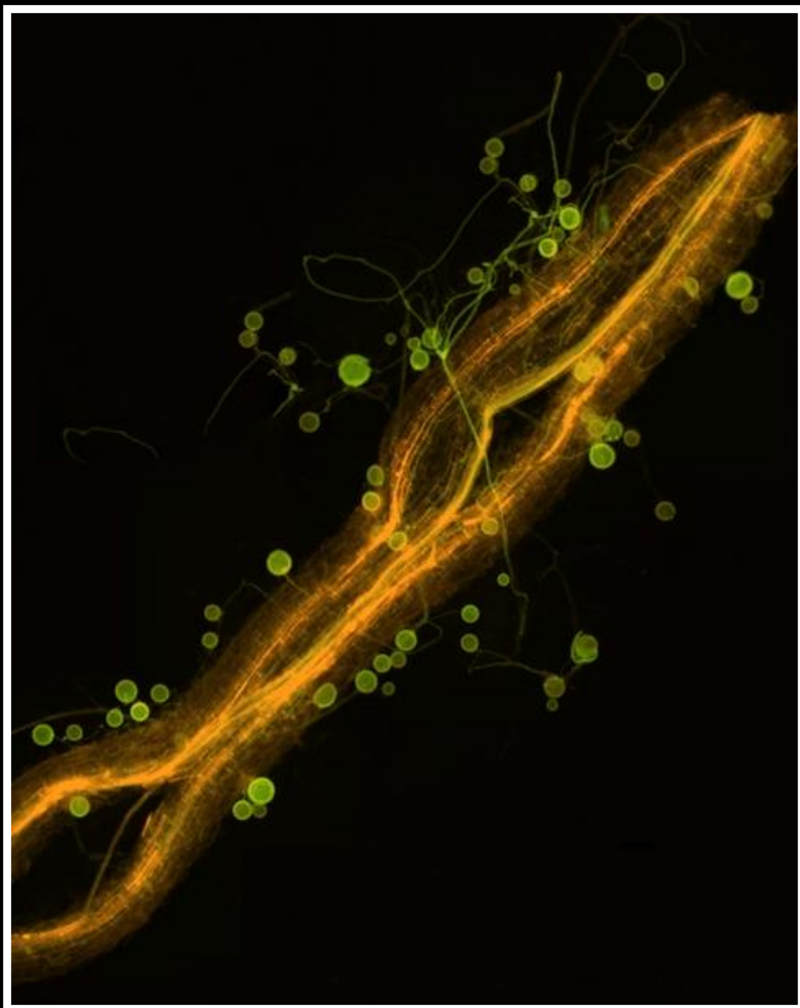


Implications and significance

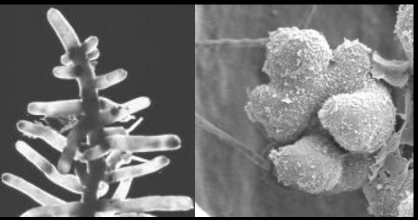
- AM fungi are ubiquitous in soils and the mycorrhizal conditions better reflects the natural stage
- AM fungi lead to qualitative and quantitative changes in the plant transcriptome
- AM fungi change the nutrient uptake strategy of their host, and molecular markers in the mycorrhizal stage better represent the nutrient efficiency under field conditions
- Integration of mycorrhizal fungi into breeding could represent a new strategy for the development of nutrient efficient and stress resistant cultivars

Research Gaps



- What is the basis of fungal or plant diversity in plant benefit?
- Are these differences based on presymbiotic or postsymbiotic events?
- How can the host plant maximize its symbiotic benefit from one fungal partner or from AM fungal communities?
- Transcriptome analysis of prairie cordgrass, switchgrass, and Brachypodium



Acknowledgements

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Brandon Monier

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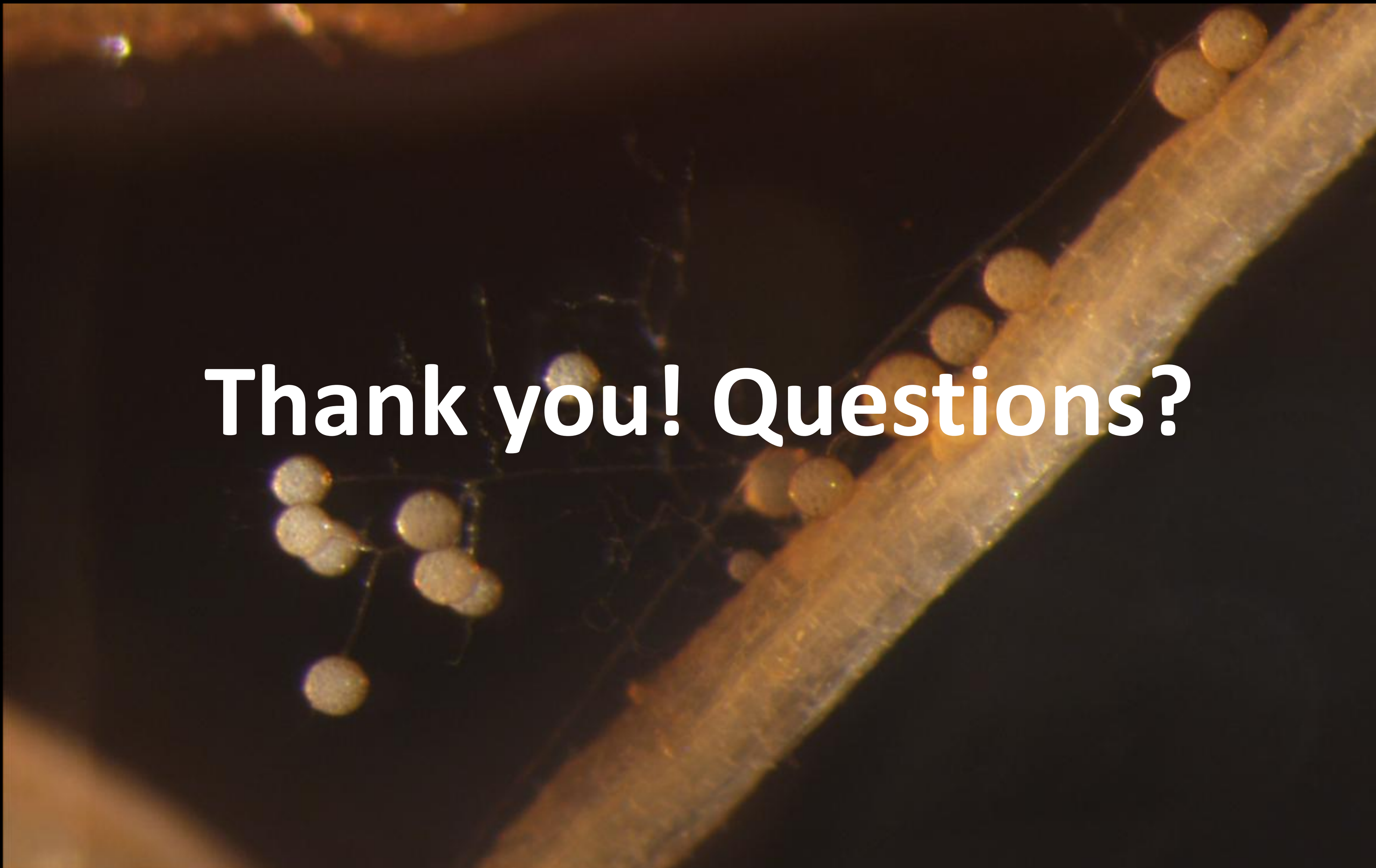
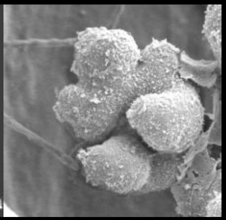
Gautam Sarath

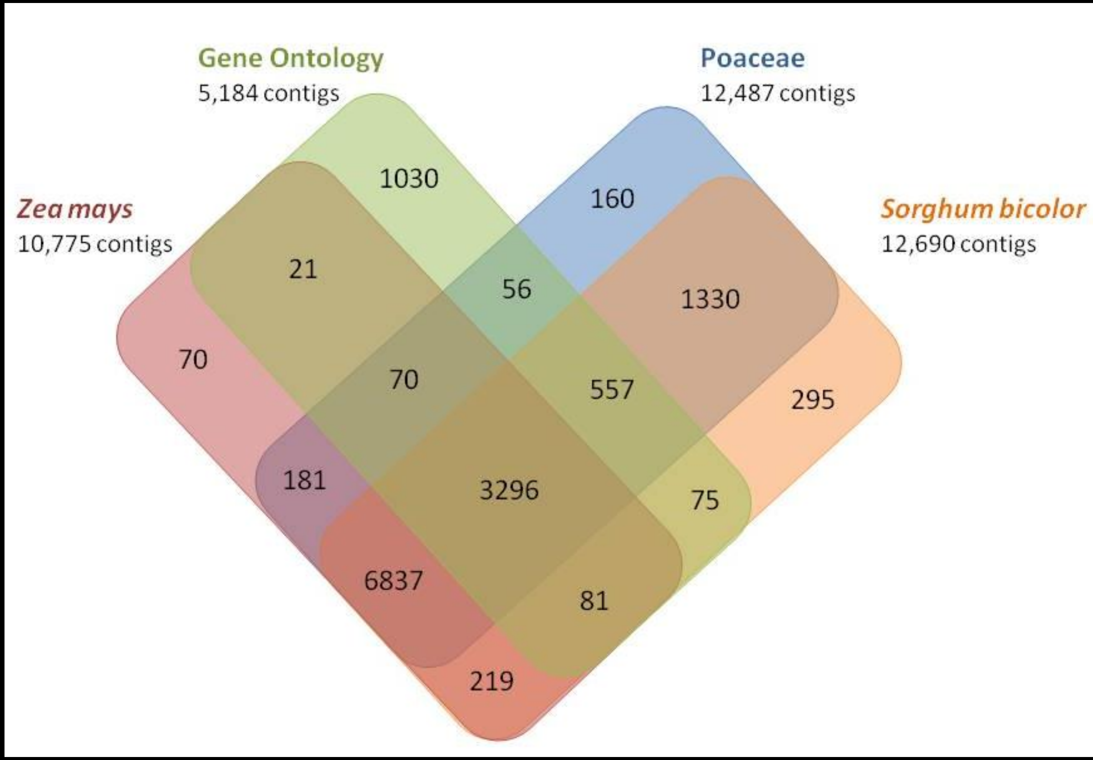
Thank you! Questions?

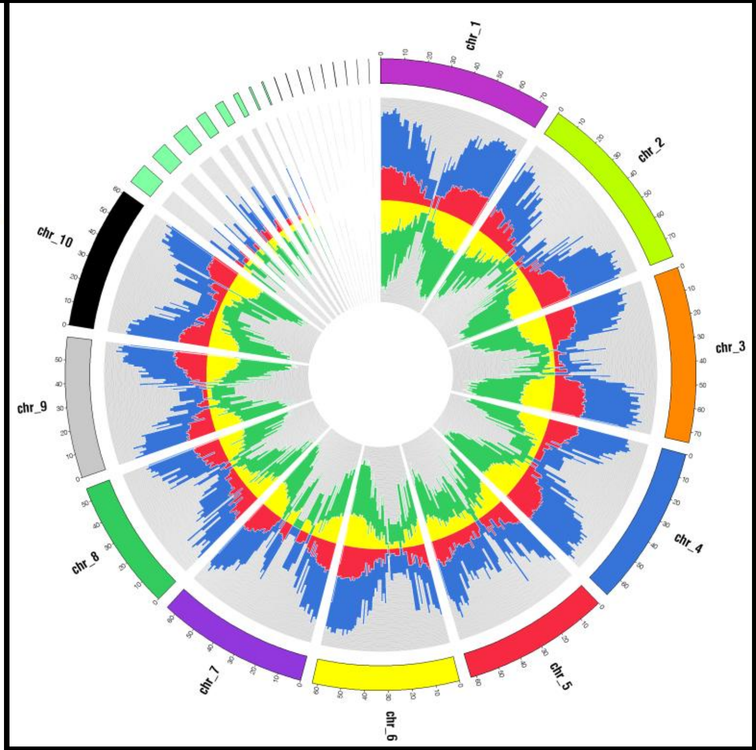


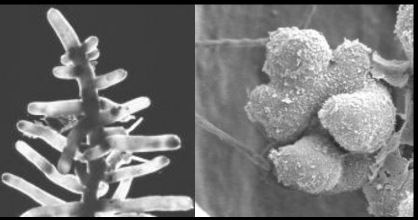



454 Transcriptome

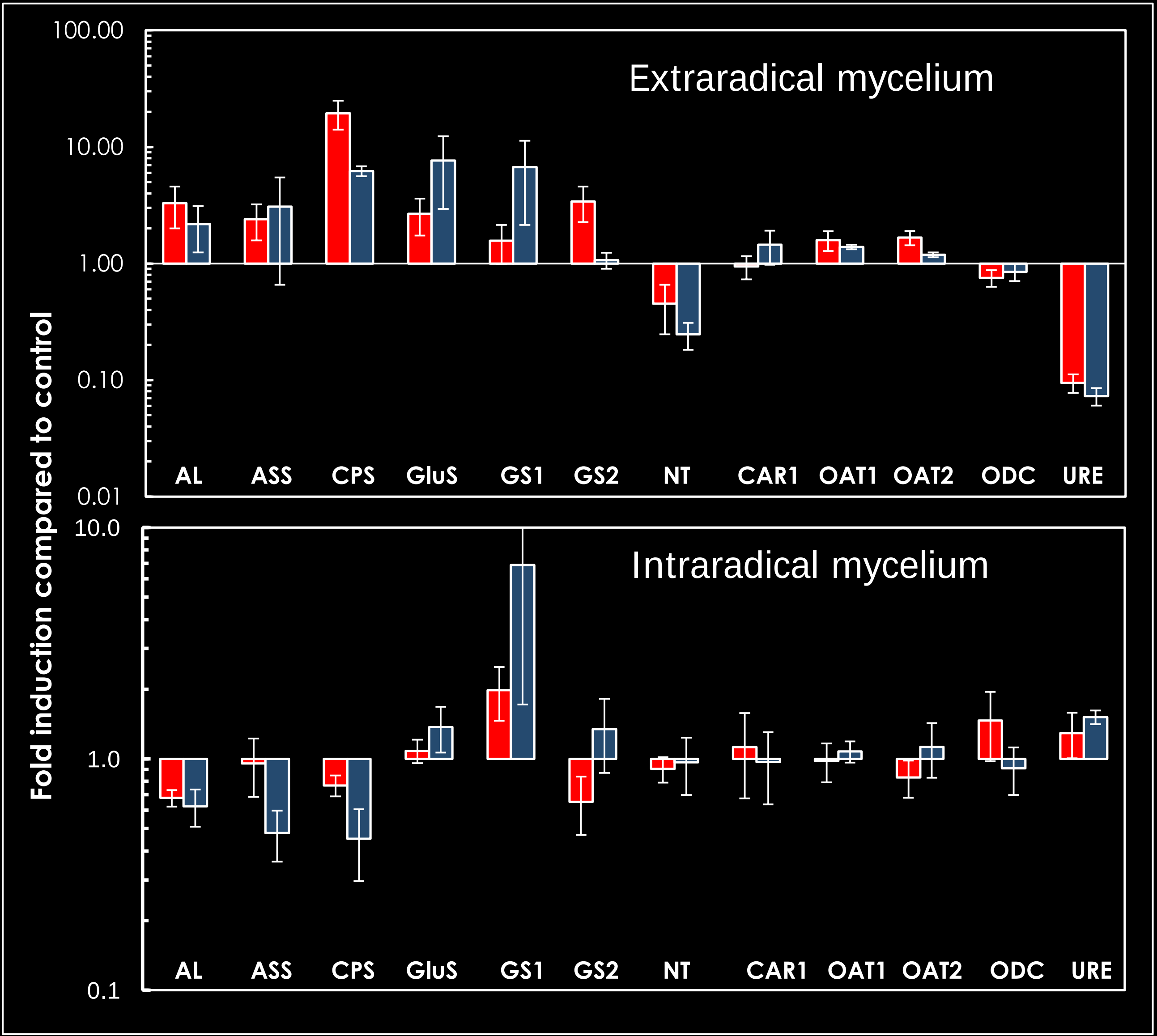
556,421 reads (average size=223bp) Assembly resulted in the formation of 26,302 contigs (average length of 394bp)





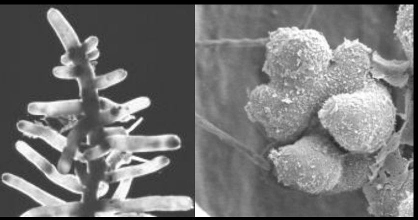


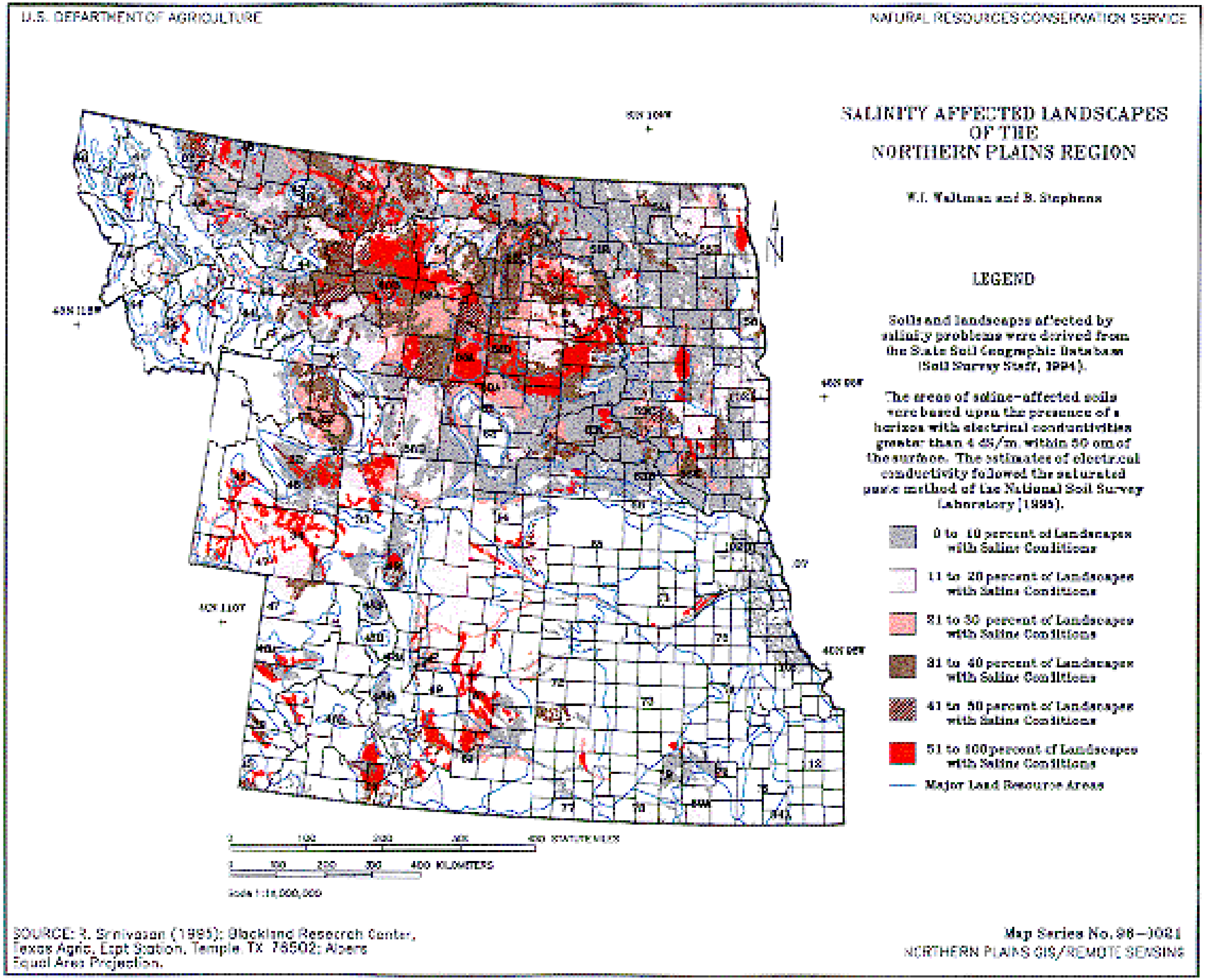
The host regulates with its carbon supply fungal gene expression



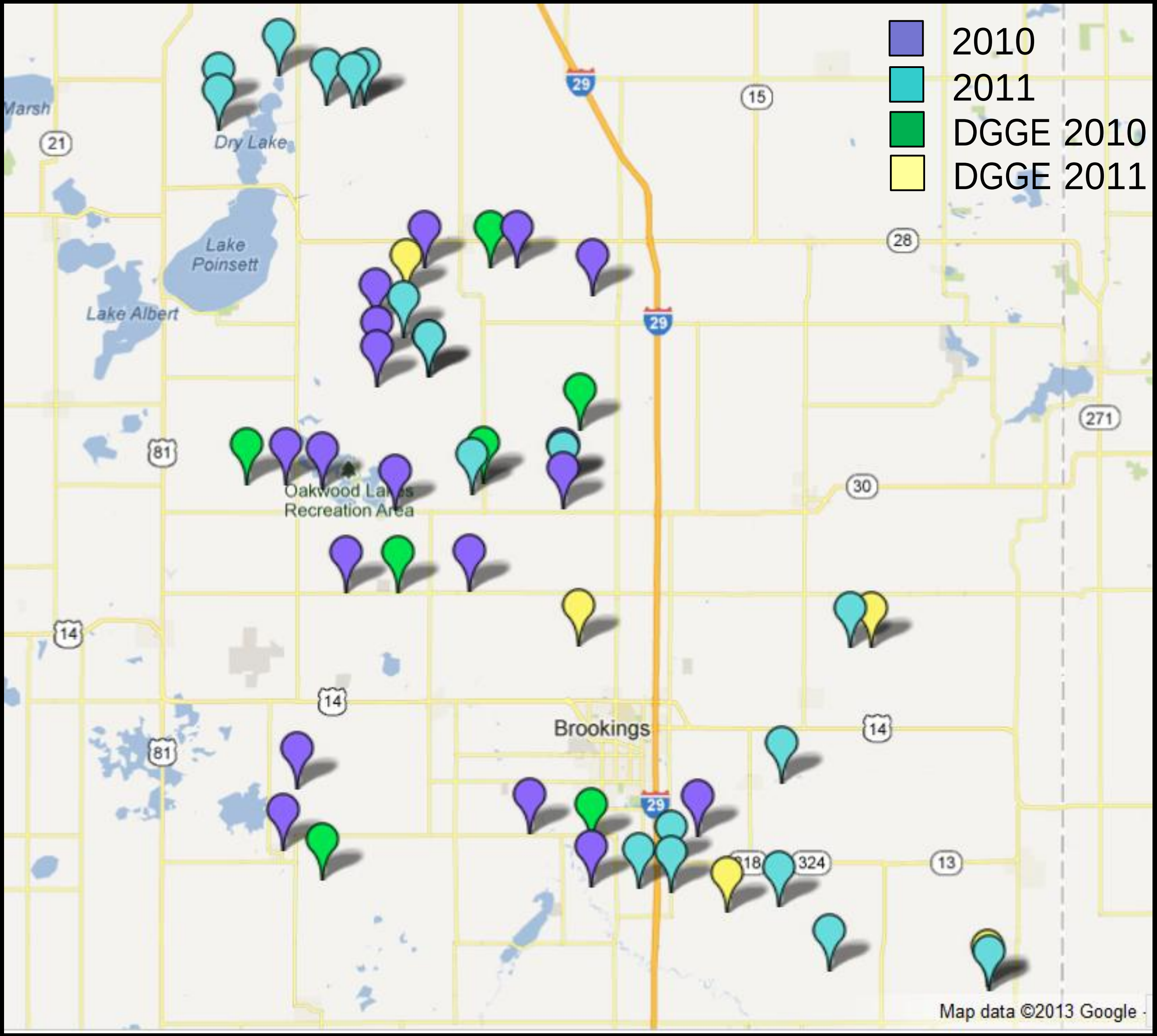
Fellbaum et al. 2012. PNAS

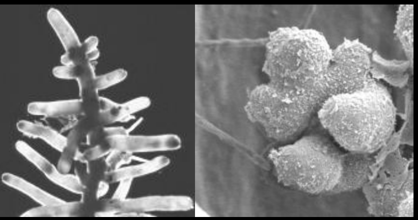
Salinity in the Northern Plains



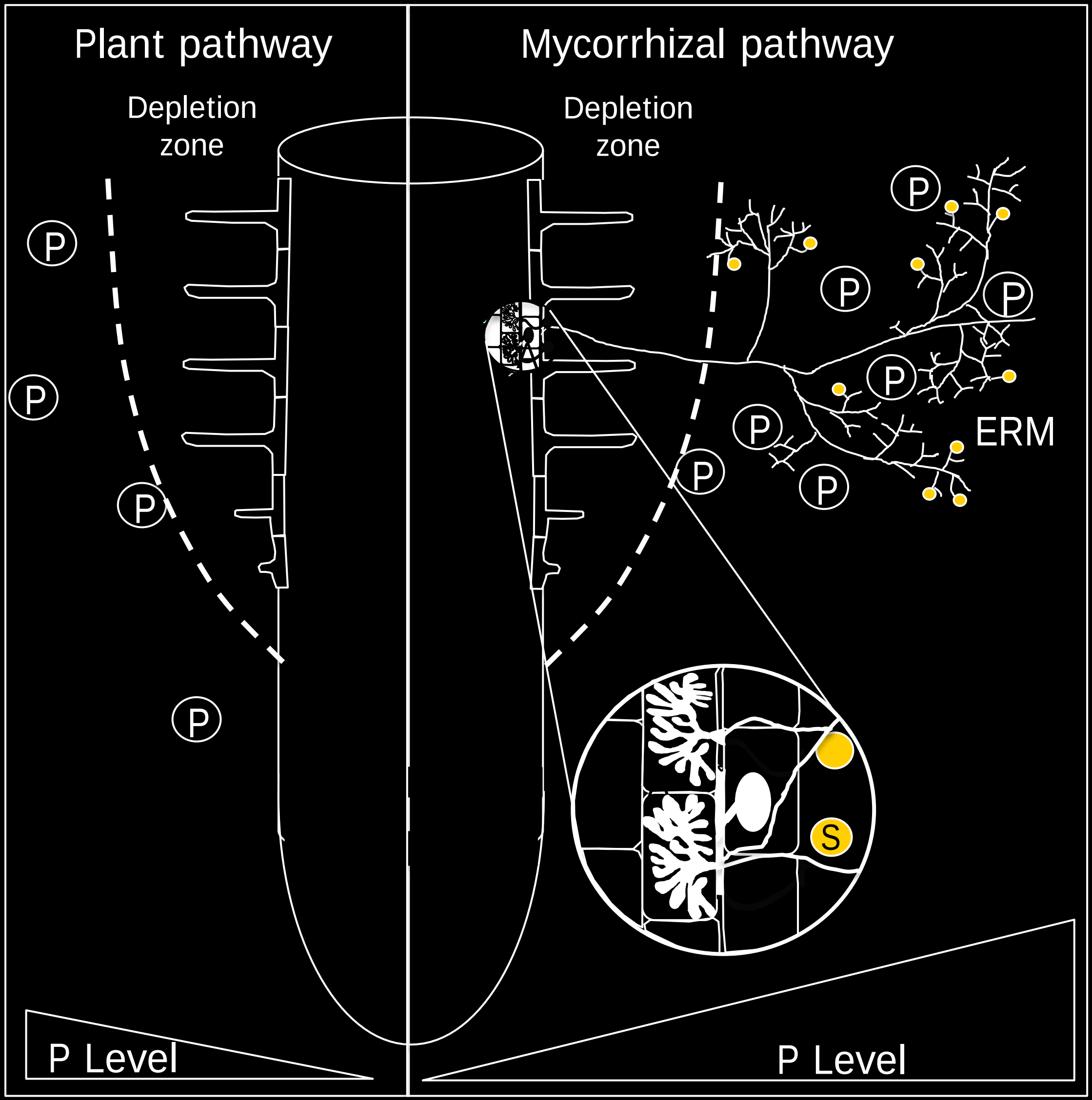


Mycorrhizal communities of prairie cordgrass

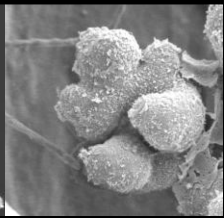




Mycorrhizal nutrient uptake

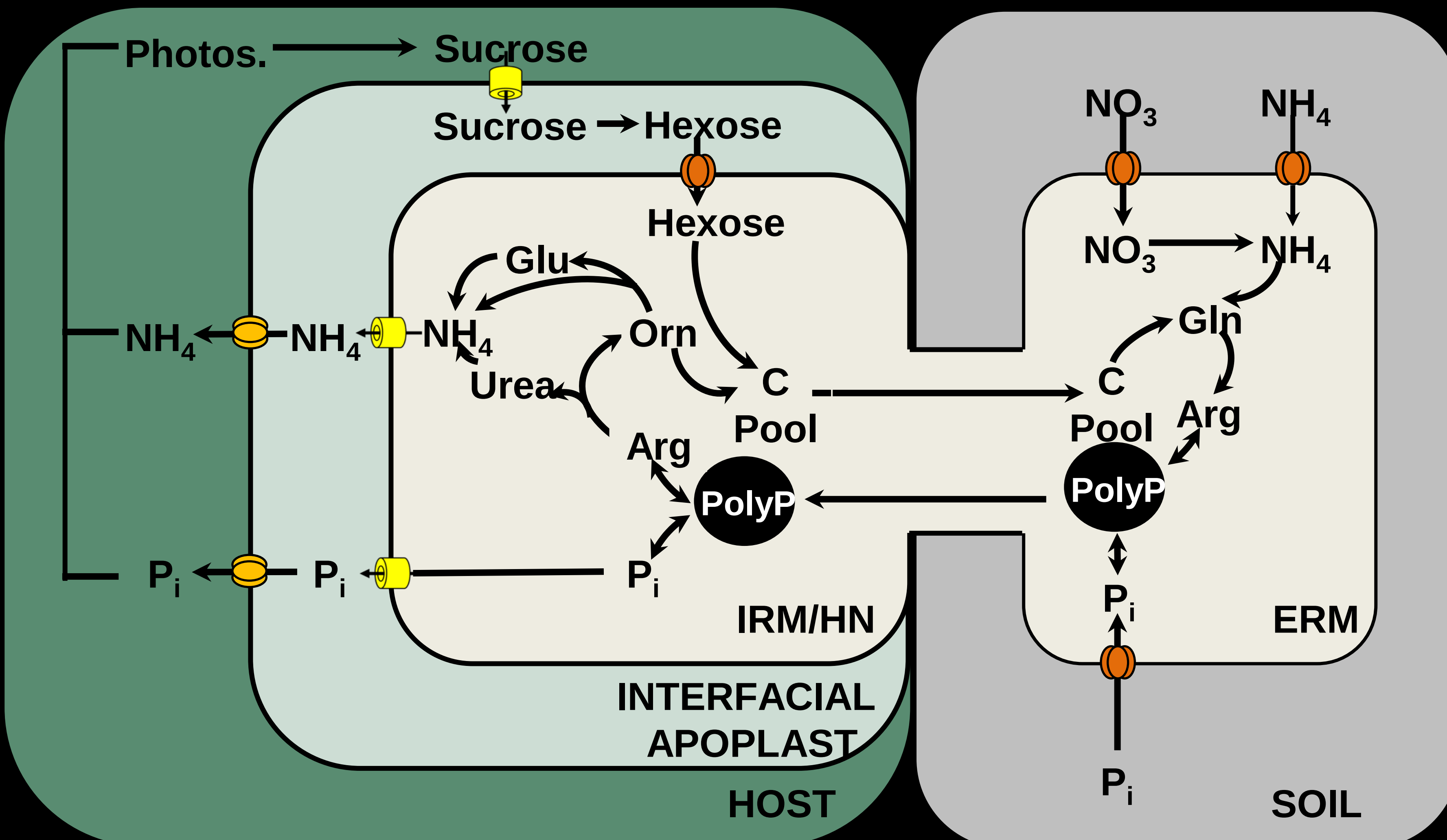


- Increase in the nutrient absorbing surface area beyond the depletion zone of the root
- Highly efficient nutrient uptake systems
- Better P storage capabilities
- Utilization of organic nutrient resources
- Connects the plant with diverse microbial communities in the soil



Resource exchange in the AM symbiosis

SDSU



Biomass potential of prairie cordgrass