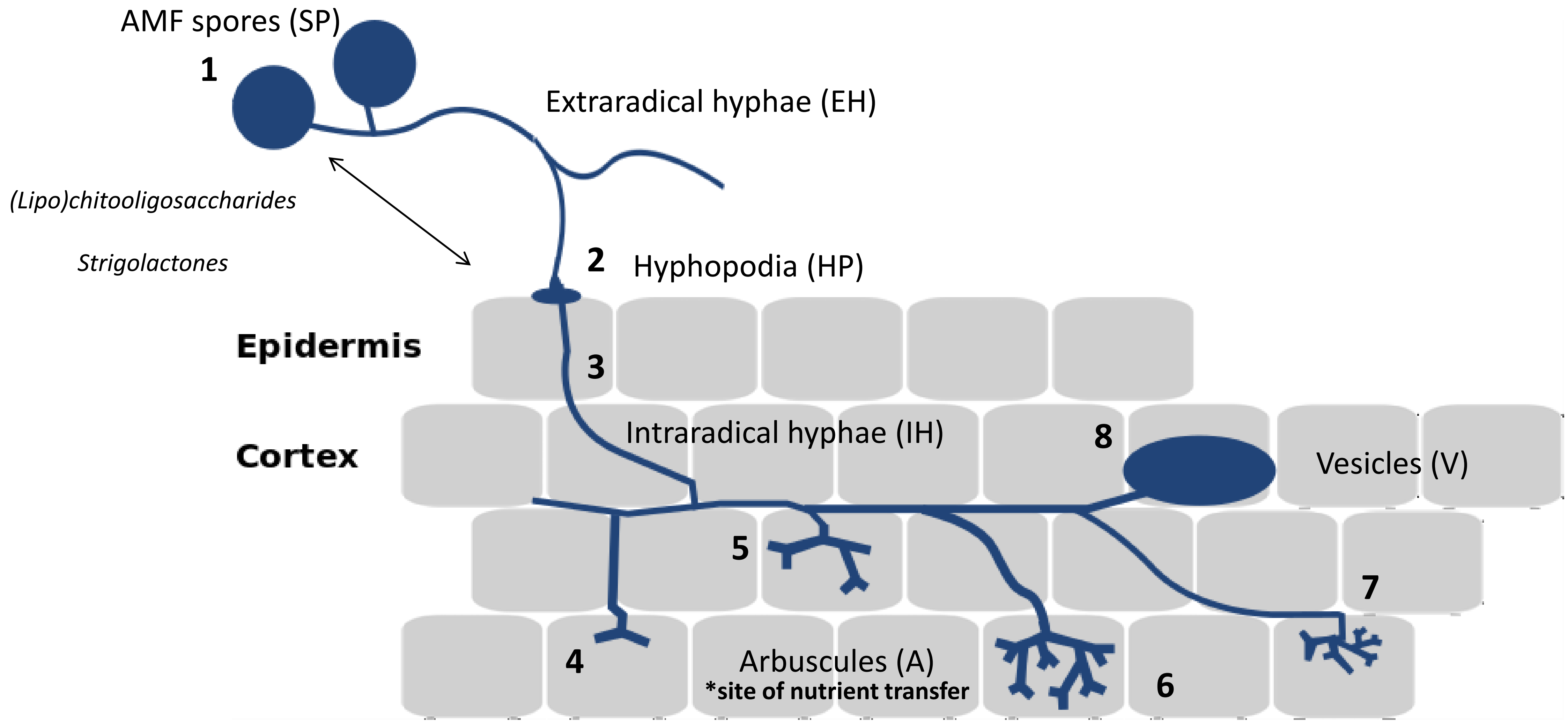
Harnessing the genetic potential for arbuscular mycorrhizal symbiosis in rice.

Flash Talk

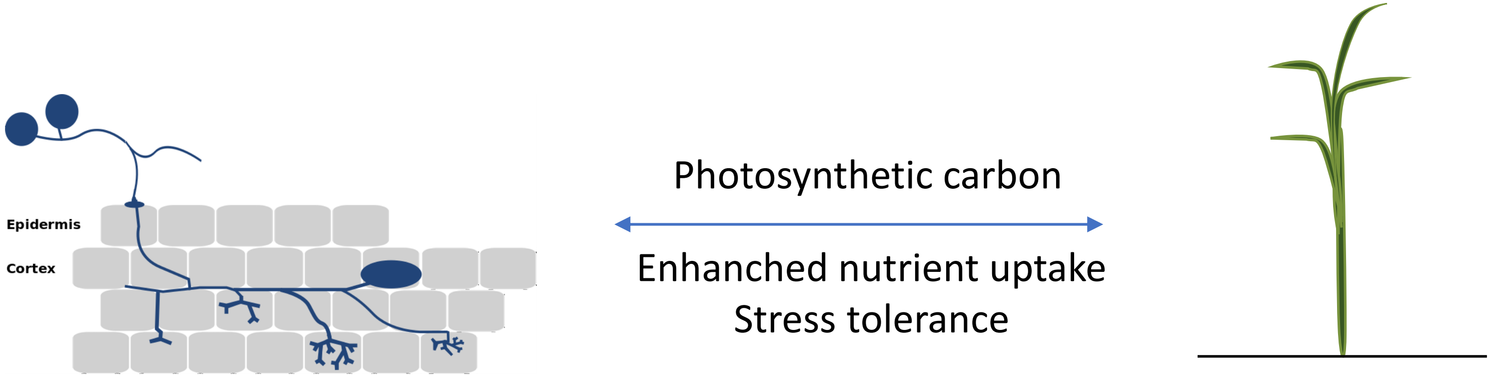
The Cambridge Global Food Security Early Career Researcher Event

Emily Kate Servanté
Paszkowski Group, Department of Plant Sciences

Arbuscular Mycorrhizal (AM) fungi form a mutually-beneficial symbiosis with plants



AM symbiosis is a genetically-driven process



Photosynthetic carbon

Enhanched nutrient uptake
Stress tolerance

AMF are important in low fertilization sustainable agrosystems.

- AM benefit (i.e. enhanced growth) = relative benefit – cost of photosynthetic carbon transfer
- Variation has previously been reported between maize lines; increased relative growth correlated to increased EH presence and greater symbiotic phosphate acquisition in superior lines (Sawers et al. 2017).

Is AM benefit similarly genetically-driven in rice?
What is the genetic basis underlying AM establishment (for introgression into favourable lines)?

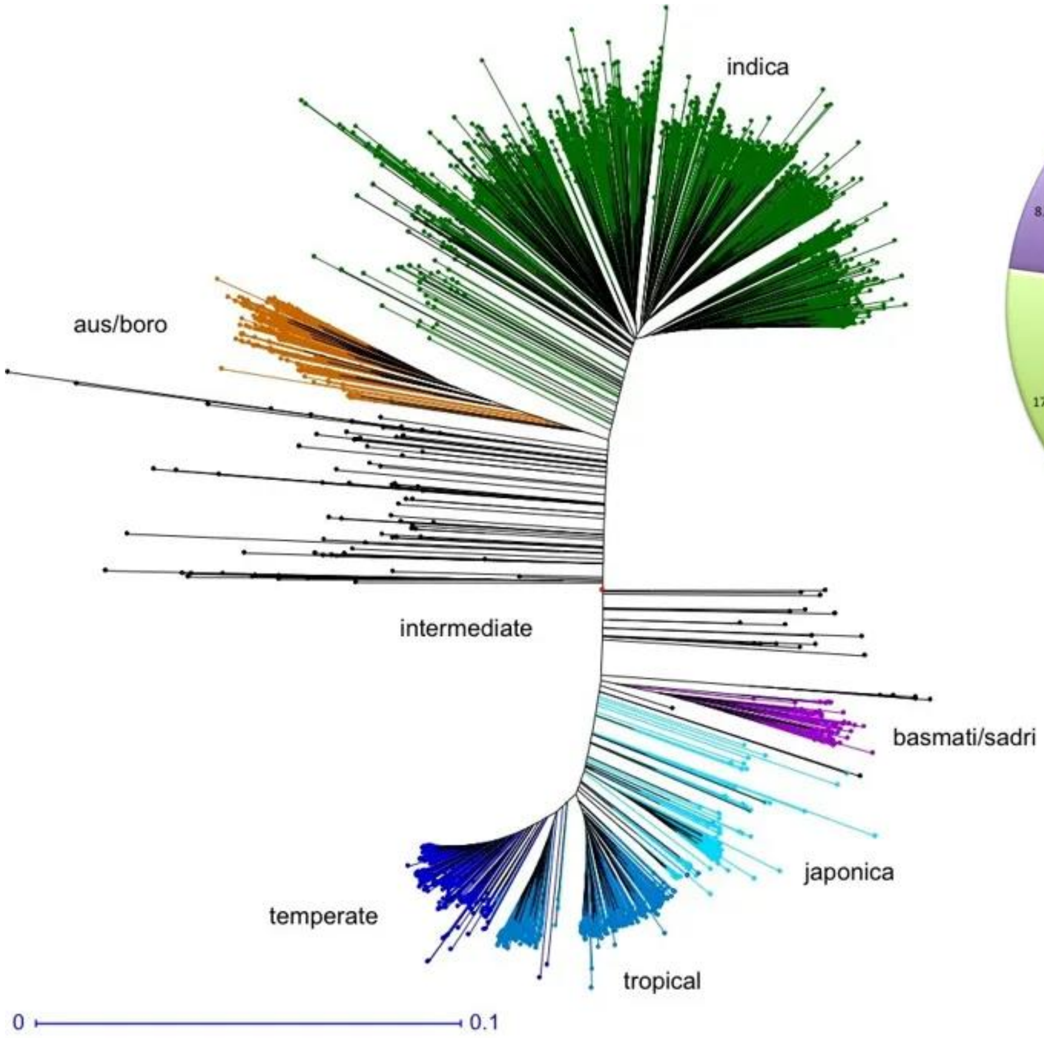
Sawers, R. J. H. *et al.* Phosphorus acquisition efficiency in arbuscular mycorrhizal maize is correlated with the abundance of root-external hyphae and the accumulation of transcripts encoding PHT1 phosphate transporters. *New Phytol.* **214,** 632–643 (2017).

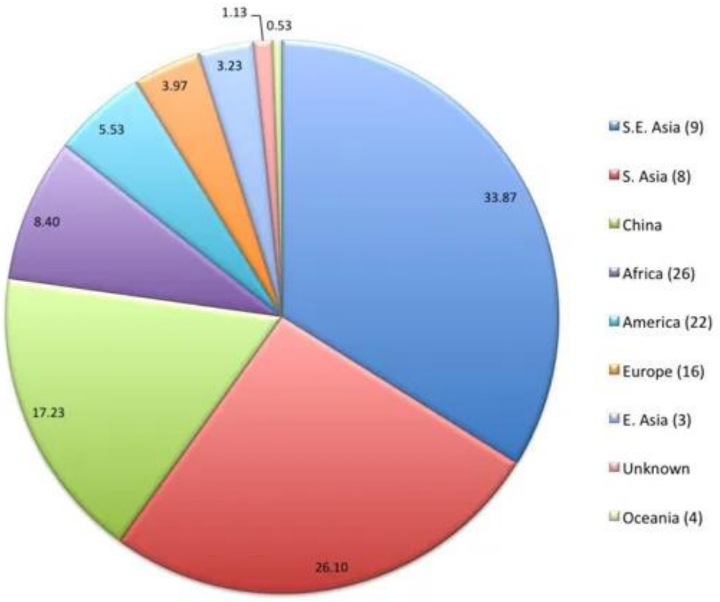
The 3K rice dataset provides a unique panel for GWAS studies in rice

- Genome Wide Association Mapping (GWAS) uses diversity panels to correlate patterns of genetic variation to a trait of interest

3K Rice Genomes Project:

- 3024 accessions
- 89 countries
- Average of **14x genome coverage** and overall **~29 million SNPs** (Wang et al. 2018)

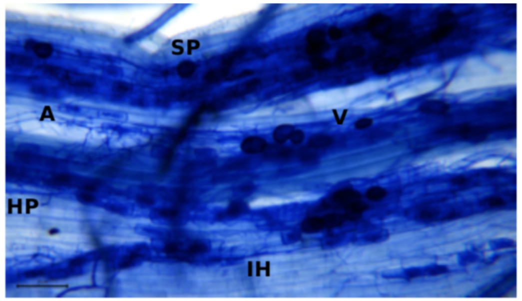




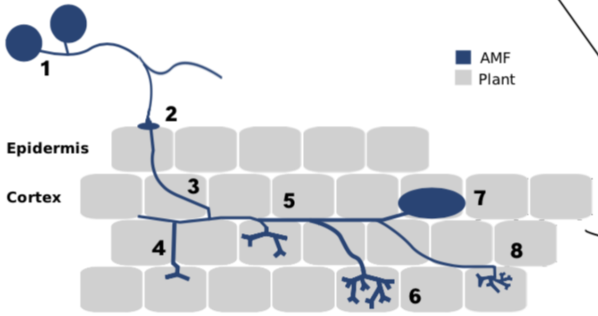
as % fraction of total

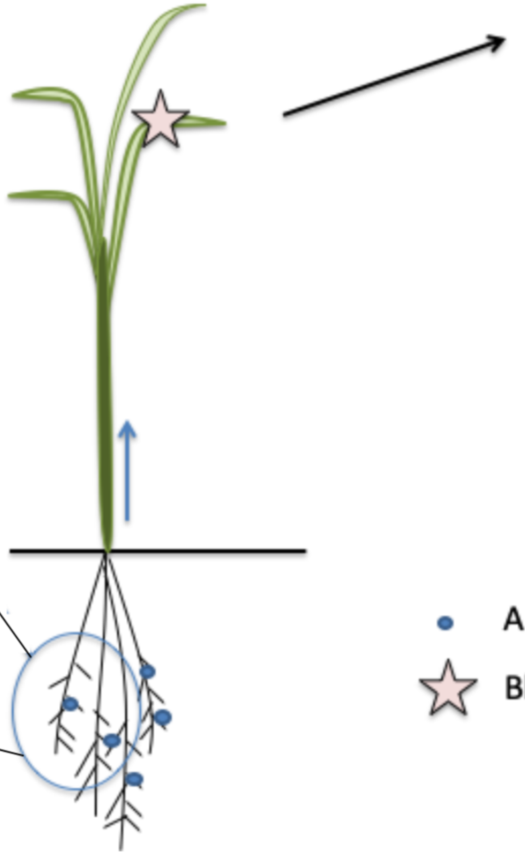
Wang, W. *et al.* Genomic variation in 3,010 diverse accessions of Asian cultivated rice. *Nature* **557,** 43–49 (2018).

Exploring blumenol abundance correlation to AM colonisation in rice

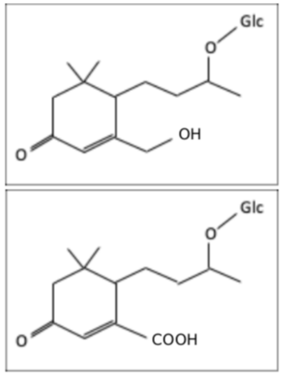


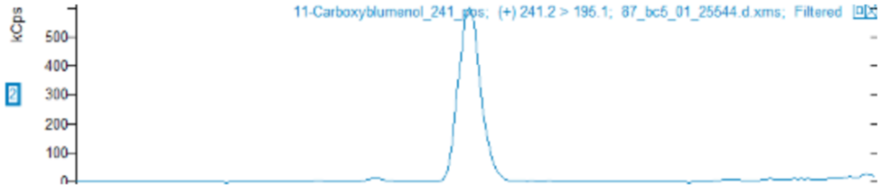
A: arbuscules, HP: hyphopodia, IH: intracellular hyphae
SP: spores, V: vesicles





Blumenol derivatives





● AM colonisation

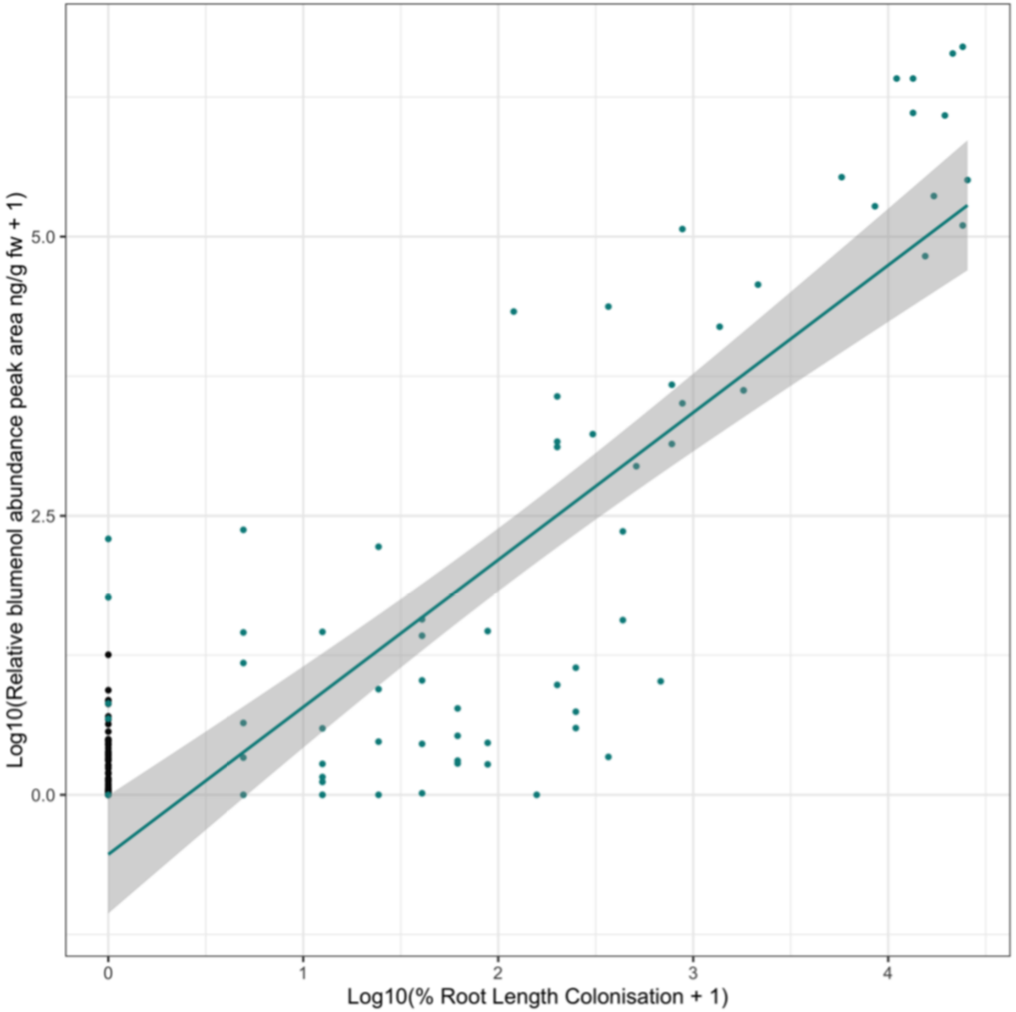
☆ Blumenols

Foliar blumenol abundance provides a high-throughput method for analysis of AM colonization in multiple crop and model species.

Rice had not yet been tested.

Wang, M. et al. Blumenols as shoot markers of root symbiosis with arbuscular mycorrhizal fungi. Elife 7, (2018)

Exploring blumenol abundance correlation to AM colonisation in rice



Significant correlation (R^2=0.83) between blumenol abundance and level of rice root colonisation, and maintained in the presence of variable Pi status of the plant.

11-carboxyblumenol C-Glc derivative

m/z 403.2 molecular ion $[M^{+}H]^{+}$

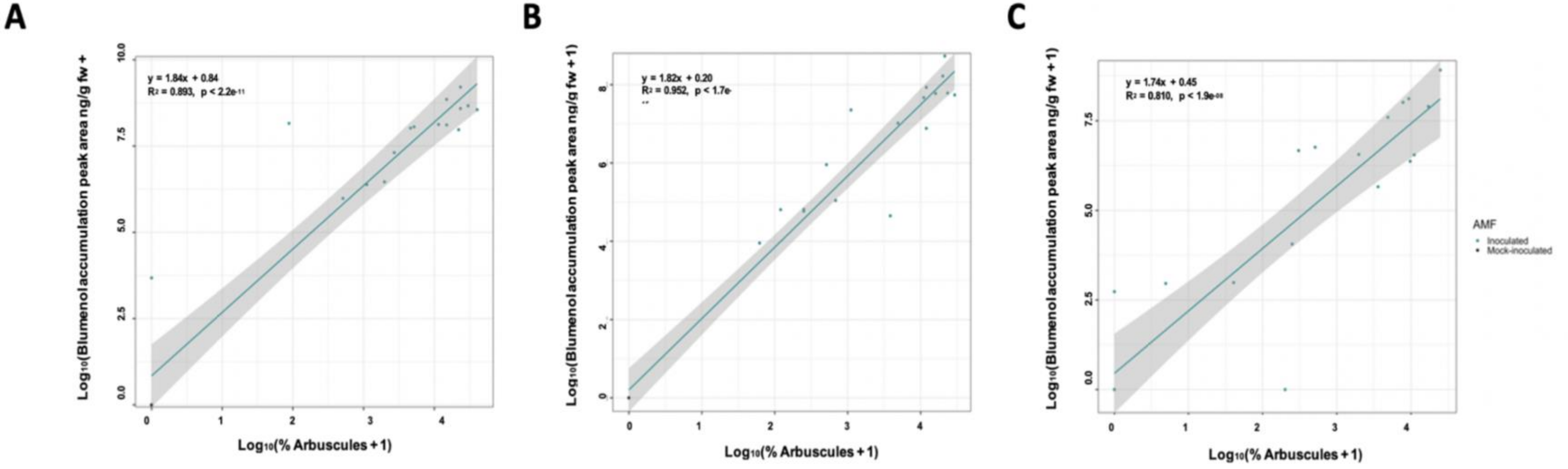
$y = 0.638x - 0.084$

$R^2 = 0.833$, p=0

Exploring blumenol abundance correlation to AM colonisation in rice

Blumenol as a shoot marker in diverse rice cultivars

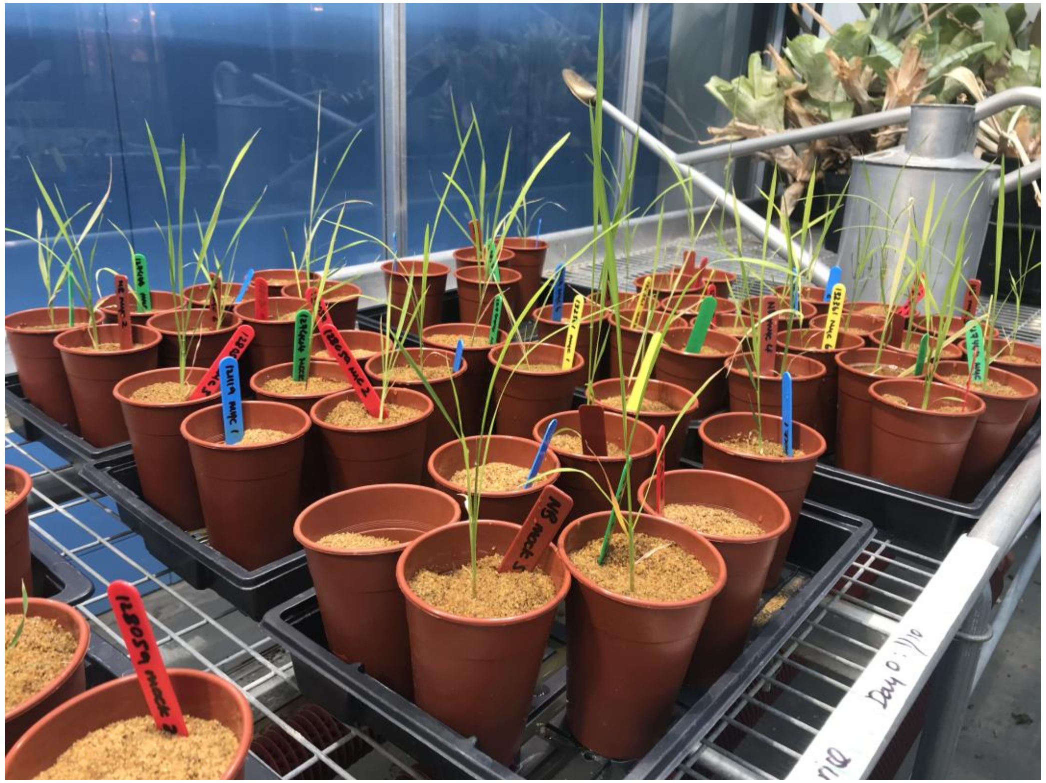
Correlation of foliar blumenol accumulation to AM colonisation rates is maintained in inoculation gradient experiments in Nipponbare (A), Dongjin (B) and Shiokari (C) cultivars of rice.

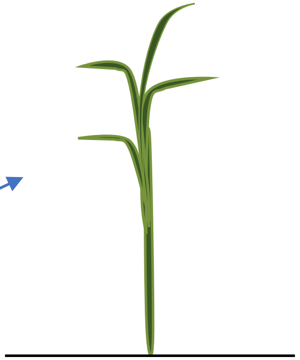


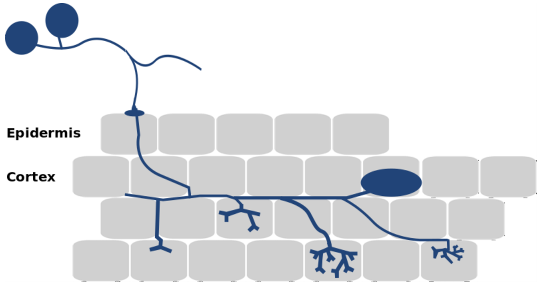
Identification of genetic regions that associate to AM symbiosis and ‘AM benefit’

PhD Plan:

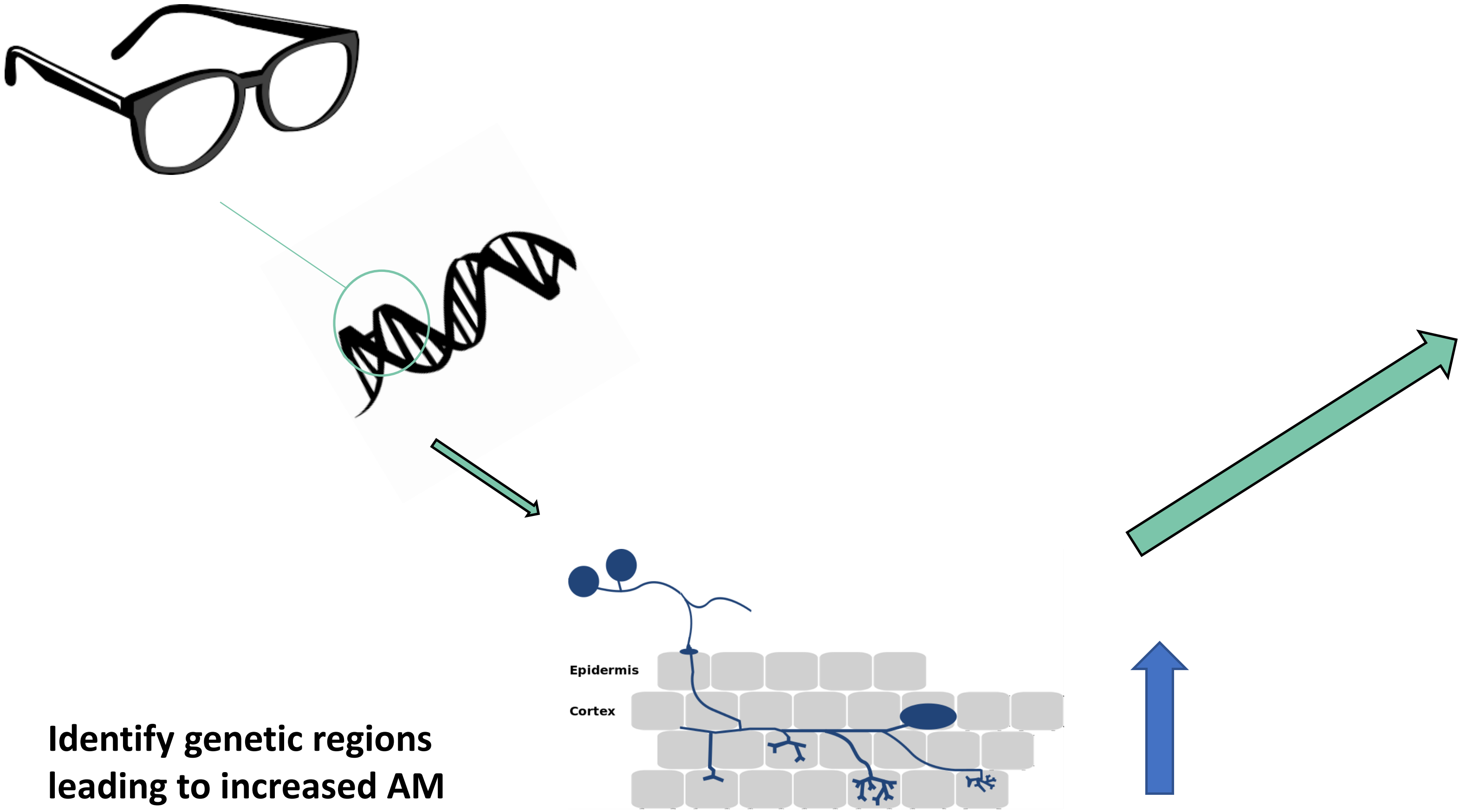
- Grow 200 diverse rice lines and measure AM colonization (blumenol), shoot biomass and nutrient composition in mock and inoculated lines
- Identify genetic regions associated to AM symbiosis and AM benefit,



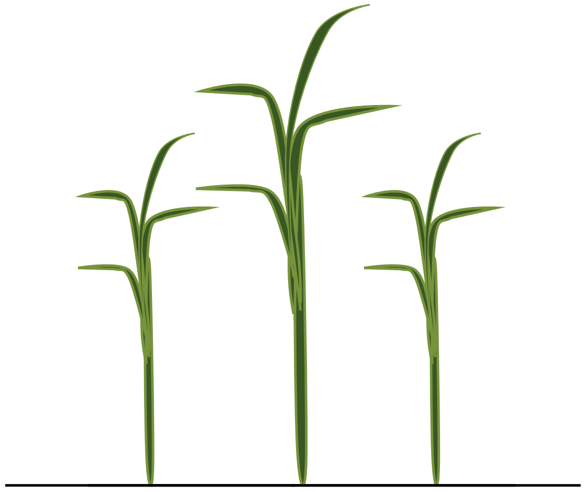




Influence on food security



Identify genetic regions leading to increased AM colonization and mycorrhizal benefit



- Produce the best lines for growth of upland rice under AM fertilization

✓ Reduce reliance on high input fertilization farming

✓ Reduce pressure on irrigation systems

Acknowledgements

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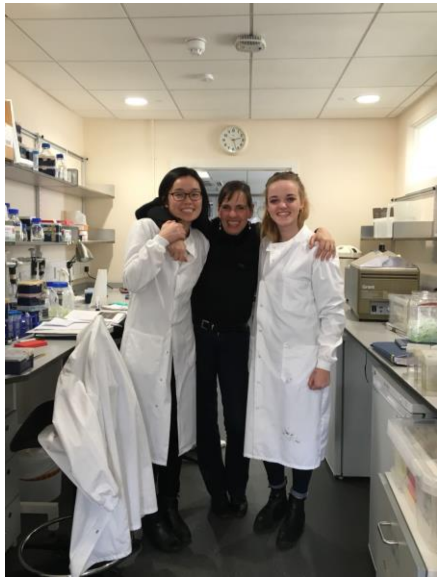

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Dr. Amelia Henry

IRRI International Rice Research Institute

Prof. Ian T Baldwin
Dr. Rayko Halitschke
Ana Rocha

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