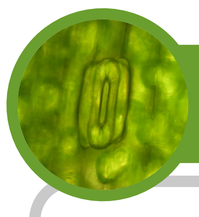
Function of Xylans in Grass Stomata

Shauni McGregor[1], Julie Gray[2], Andrew Fleming[1]
[1]Department of Animal and Plant Sciences, University of Sheffield, UK
[2]Department of Molecular Biology and Biotechnology, University of Sheffield, UK
srmcgregor1@sheffield.ac.uk
shauni_mcgregor

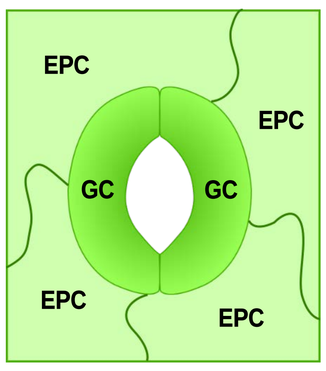
Plants control their rate of gas exchange to best suit the current environment by changing the size of their stomatal pores. This is facilitated by the guard cells, which reversibly change shape in order to modulate the aperture of the stomatal pore. To facilitate this shape change, the guard cell wall is repeatedly deformed and must undergo recurrent stress and strain. This is reflected by the specialised structure of the guard cell wall, making the stomatal complex an interesting system in which to study cell wall mechanics.



Grass stomata have a characteristic structure

Eudicots

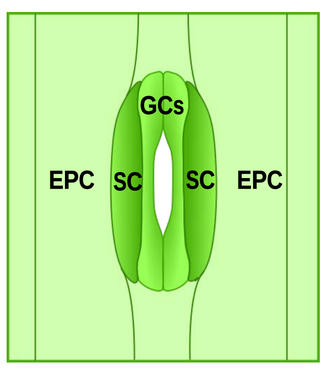
e.g. tomato, *Arabidopsis thaliana*



- Kidney shaped guard cells (GCs)
- Guard cells surrounded by epidermal pavement cells (EPCs)

Monocots

e.g. barley, *Brachypodium distachyon*



- Dumbbell shaped guard cells (GCs)
- Lateral subsidiary cells (SCs)
- Cells arranged in parallel files

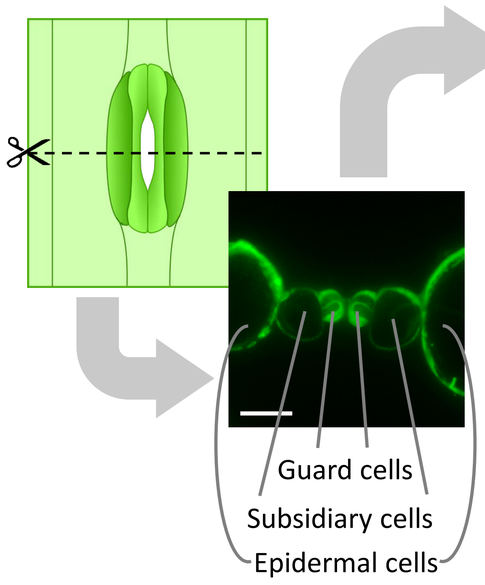
Grasses also have a characteristic cell wall composition

- High in pectin
- Low in xylan
- Xylan only found in secondary cell walls (e.g. xylem fibres)

- Low in pectin
- High in xylan
- Xylan found in both secondary and primary cell walls

Grass guard cells are rich in xylan

- Xylan is a hemicellulose important in cell wall integrity and recalcitrance.
- Guard cells from multiple grass species show high levels of xylan.
- *Arabidopsis thaliana* has no detectable xylan in its guard cells.



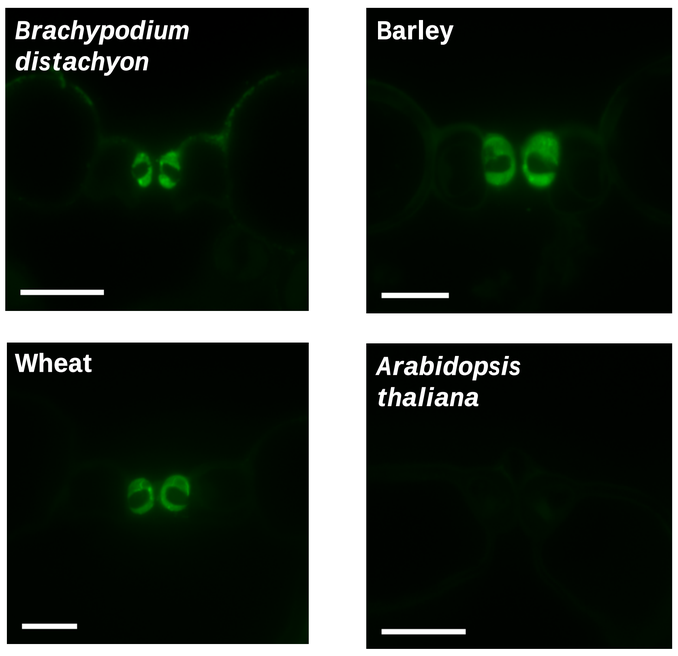


Figure 1. Immunolabelling screens using a xylan specific antibody on transverse leaf sections from three grass species and the model eudicot *Arabidopsis thaliana*. Green signal indicates antibody binding. Scale bars represent 10µm.

Grass guard cell xylan is different to the xylan in the surrounding epidermis

- Xylan polymers can be substituted with a wide range of different chemical groups.
- Grass guard cells are rich in ferulic acid.
- The surrounding epidermis is rich in glucuronic acid.

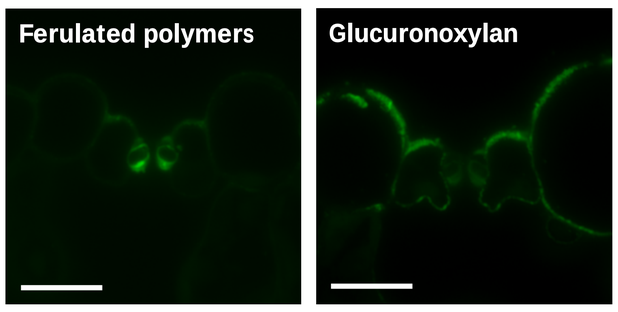


Figure 2. Immunolabelling screens using antibodies specific to ferulated polymers and glucuronoxylan on transverse leaf sections from *Brachypodium distachyon.* Green signal indicates antibody binding. Scale bars represent 10µm.

Xylan is required for stomatal opening in barley

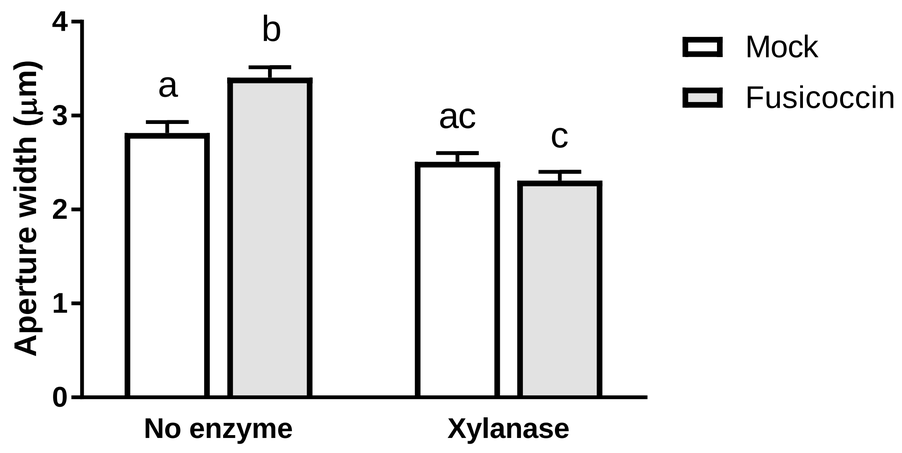


Figure 3. Results from stomatal function bioassays on barley leaf tissue. Xylanase treatment of leaf tissue inhibits fusicoccin induced stomatal opening.

… but not in *Arabidopsis thaliana*

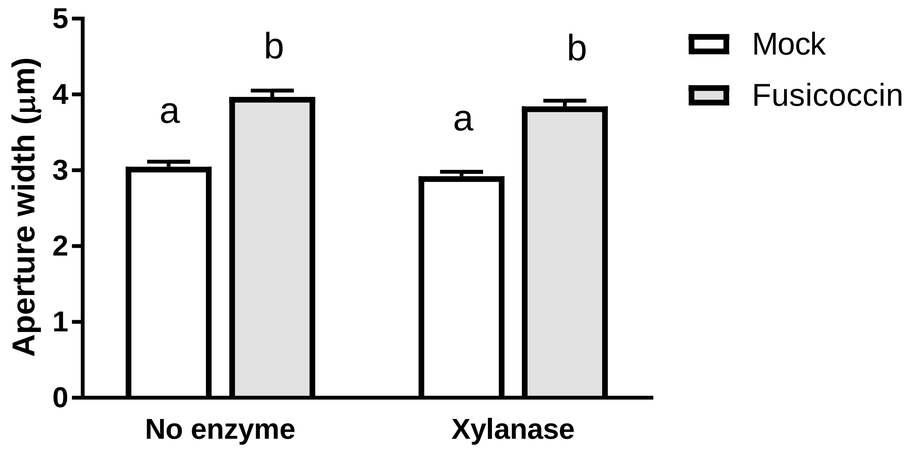


Figure 4. Results from stomatal function bioassays on *Arabidopsis thaliana* leaf tissue. Xylanase treatment of leaf tissue does not change fusicoccin induced stomatal opening.

Further questions and future work

What genes are responsible for xylan synthesis in stomata?

- Identify putative grass xylan synthesis genes.
- Screen grasses with altered stomatal density for changes in xylan synthesis gene expression.

What is the role of xylan in the grass stomatal complex?

- Investigate affect of xylanase treatment on stomatal closing responses.

Are xylans important in the stomata of other plant species?

- Screen stomata from non-grass monocots for presence of xylans using immunolabelling assays.

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