

HELPING PLANTS BREATHE UNDERWATER

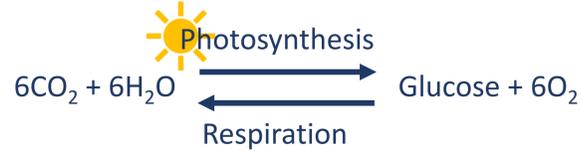
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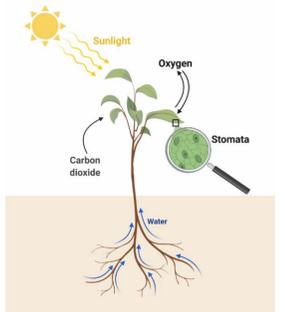
1 The Flooding Problem

- Flooding is the 2nd largest contributor to **global crop losses**.¹
- The frequency and severity of flooding events are increasing due to **climate change**.
- Innovations that **protect plants from floods** are important for achieving **food security** in the future.

This research aims to develop a chemical treatment that will improve plant flood tolerance.



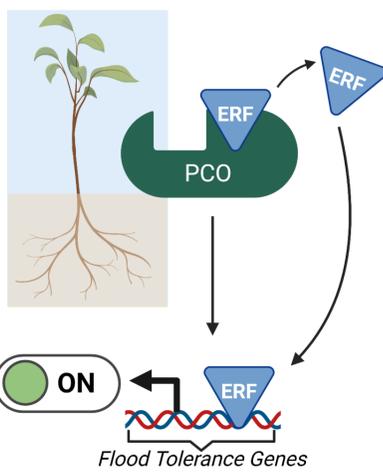
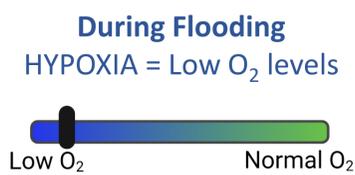
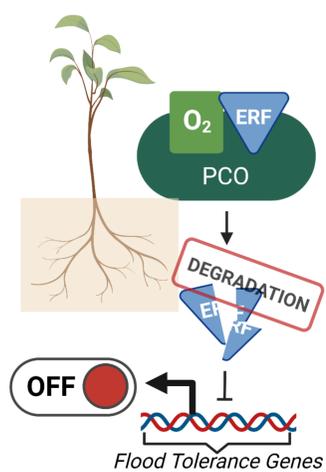
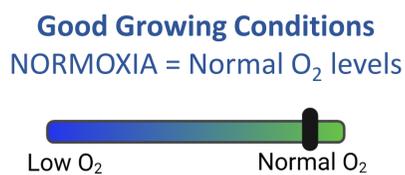
- During flooding, diffusion of O₂ into plant tissues is limited, resulting in reduced O₂ levels (= **hypoxia**).
- This **halts aerobic respiration** and triggers expression of genes that help plants tolerate the stressful hypoxic conditions.



2 Breathing Underwater

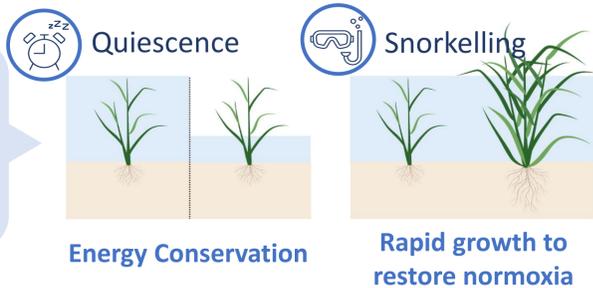
Flooding causes low O₂ levels in plant tissues

- Enzymes called **Plant Cysteine Oxidases (PCOs)** are key for O₂ sensing in plants.²
- PCOs regulate the stability of flood-stress signalling proteins called **Ethylene Response Factors (ERFs)**.
- When stabilised, ERFs **switch ON flood tolerance genes**.

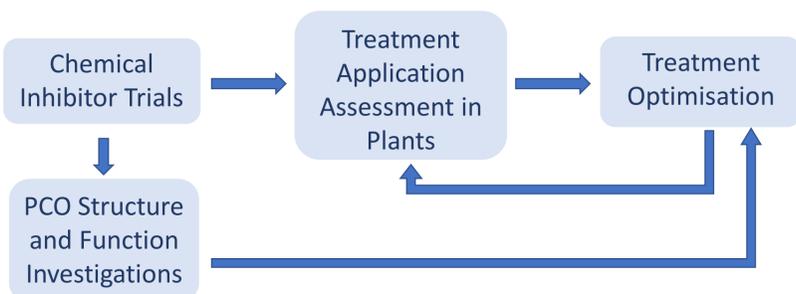


What do flood tolerance genes do?

Scientists discovered that flood tolerance genes (switched on by ERFs) resulted in **two flooding survival strategies...**



5 The Next Steps



Acknowledgements

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References

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2. D. A. Weits et al., *Nature Communications*, 2014, **5**, 3425.
3. S. Hartman et al., *Nature Communications*, 2019, **10**, 4020.
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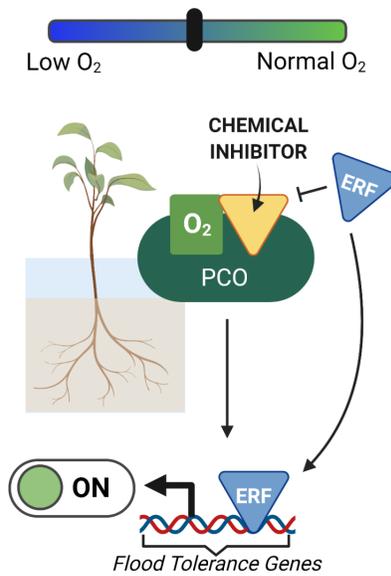


3 Chemical Treatment Strategy

How will a chemical treatment help?

- Plants switch on flood tolerance genes **during flooding** when O₂ levels are low.
- Research suggests that switching flood tolerance genes on **prior to flooding** improves plant survival.^{3,4}
- This could be achieved by inhibition of PCO enzymes.

Chemical Treatment Application
PRE-HYPOXIA



HYPOTHESIS:
A chemical treatment that inhibits PCOs will prolong plant flood tolerance

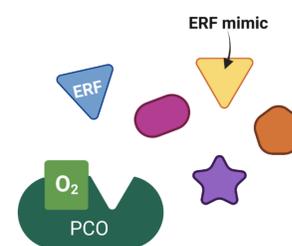
RATIONALE:
ERFs will be protected from PCO initiated degradation and lead to expression of flood tolerance genes **prior to flooding**.



4 Searching for Chemical Inhibitors

Chemical inhibitors are like puzzle pieces...

Their shape must be **complementary** to the **ERF binding site** on PCO enzymes so that they can block **ERFs from binding**.



We are trialling two types of chemical inhibitors:

- **ERF mimics** – These are proteins with structural similarities to ERF proteins.
- **Small molecules** – These have a carbon framework and follow the traditional format of agrochemicals.

Experiments that monitor ERF proteins can determine the impact chemicals have on PCO enzyme activity

- **14 x ERF mimics** have been trialled to assess their inhibitory properties towards PCO enzymes.
- Surprisingly, the ERF mimics did **not** inhibit PCOs. Instead, they **increased** PCO activity.
- By investigating why PCO activation occurs we can learn more about the **enzyme structure and function**.

A comparison of PCO enzyme activity with an ERF mimic present

