

Improving plant cold tolerance to enhance agricultural resilience to abiotic stress

Supervisory team:

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Project description:

Abiotic stresses have a substantial impact upon both photosynthesis and crop production, with these losses predicted to grow through the environmental unpredictability arising from climate change. Photosynthesis within chloroplasts underlies all agricultural productivity, so understanding the role of chloroplasts in stress responses is an important part of developing stress-resilient crops for the future. Chloroplasts contain a small circular genome of cyanobacterial origin that encodes essential components of the photosynthetic apparatus. This PhD studentship will build on our recent breakthroughs into the signalling pathways that communicate environmental information to chloroplasts (Noordally et al. *Science* 2013; Belbin et al. *New Phytol.* 2017). In this project, the student will investigate how changes in chloroplast gene expression adapt plants to cold temperatures. The research will combine underpinning experiments using the model plant *Arabidopsis thaliana*, and findings will be translated into wheat to understand how these signalling mechanisms improve the abiotic stress tolerance of a globally-important crop.

The project will investigate the following questions:

1. How does chloroplast gene expression increase the cold tolerance of *Arabidopsis*? This will involve experiments studying ROS production, cellular biochemistry, signal transduction and photosynthesis.
2. What is the relationship between cold tolerance, chloroplasts and the circadian clock? This will involve physiological and photosynthetic assays, combined with bioluminescence circadian time-course imaging and molecular methods, to address this question.
3. How is the cold tolerance of wheat enhanced by mechanisms that regulate chloroplast gene expression? These experiments will use a small, rapid cycling variety of wheat called Apogee as an experimental model system. This will involve CRISPR-CAS9 genome editing alongside a range of photosynthetic and physiological studies.

The project will provide important new insights into molecular and physiological processes that underlie abiotic stress tolerance of plants.