Honours Project Title: Improving the salinity tolerance of wheat and barley (1)

Supervisor(s): Dr Stuart Roy

Supervisor(s) Webpage(s): http://www.adelaide.edu.au/directory/stuart.roy

Brief Project Outline: Abiotic stresses, such as salinity and drought stress, negatively affect plant growth and potential yield. These stresses are particularly relevant to agriculture in Australia, causing multi-million dollar losses in the potential income of farmers and the agriculture industry. Worryingly, these abiotic stresses are increasing due to the effects of climate change. Improvement of the abiotic stress tolerance of Australian wheat and barley is crucial to alleviate this problem. Transgenic plants have been genetically modified to express important genes which have been shown previously to confer salinity stress tolerance. These genes have shown to be beneficial in altering the movement of the toxic sodium ions through a plant. Barley plants which were transformed with these genes were significantly more salinity tolerant than the original parental line of barley in both the greenhouse and the field. We have now developed transgenic wheat lines which have these same genes and these need to be characterised to confirm their tolerance to salinity, with a particular focus on end yield. In summary, this project will ideally suit an enthusiastic student who is interested in learning more about modern day genetic techniques being used to generate abiotic stress tolerant crop plants. The project will have both physiological and genetic aspects to it.

Techniques/Skills Learnt:

- Physiological analysis of genetically modified plants
- Elemental profiling of genetically modified plants
- Common molecular biology techniques including cloning, sequencing, plasmid isolation and DNA and RNA isolation, RT-PCR, Southern blot hybridisation
- Possibility of analysing transgenic plants undergoing field trials

Key References:

Roy, S.J., Huang, W., Wang, X.J., Evrard, A., Schmöckel, S.M., Zafar, Z.U. and Tester, M. (2013) A novel protein kinase involved in Na^+ exclusion revealed from positional cloning. *Plant Cell Environ*, **36**, 553-568.

Roy, S.J. and Tester, M. (2012) Increasing salinity tolerance of crops, Avenues and Approaches In *Encyclopedia of Sustainablility Science and Technology* (Meyers, R.A. ed. New York: Springer.

Roy, S.J., Tucker, E.J. and Tester, M. (2011) Genetic analysis of abiotic stress tolerance in crops. *Curr Opin Plant Biol*, **14**, 232-239.

Scholarship Available: Yes, $4,000 ACPFG Honours Scholarships are available (subject to conditions)*

** Scholarships are competitive and are awarded principally on academic merit.*

Want to know more? Then contact stuart.roy@adelaide.edu.au *with the subject heading 'Honours Project', so that we can have a chat about the project in more detail.*

Honours Project Title: Improving the salinity tolerance of wheat and barley (2)

Supervisor(s): Dr Stuart Roy

Supervisor(s) Webpage(s): http://www.adelaide.edu.au/directory/stuart.roy

Brief Project Outline: Loss of crop yield due to high concentrations of salt on agricultural land is a significant problem for Australian farmers. As it is expected that around 14 million hectares of agricultural land in Australia will be affected by dryland salinity by the year 2050, it is imperative that we identify genes and cellular processes which will increase the salinity tolerance of crop plants. Salinity tolerance in wheat and barley has been linked to the ability to maintain growth (osmotic tolerance) and the ability to tightly control the movement of sodium (Na^+) and chloride (Cl^-) ions through the plant (ionic tolerance). Previously in our laboratory we have identified a number of novel quantitative trait loci (QTL) in wheat and barley mapping populations that have been linked to salinity tolerance traits. Validation of these QTL and the development of markers that breeders can use for marker assisted selection (MAS) is imperative if we want to improve the ability of our current elite wheat and barley cultivars to tolerate saline soils. This project will focus on validating the QTL for osmotic and ionic tolerance in one wheat or barley mapping population. In summary, this project will ideally suit an enthusiastic student who is interested in learning more about modern day genetic techniques being used to generate abiotic stress crop plants. The project will have both physiological and genetic aspects to it.

Techniques/Skills Learnt:

- Physiological analysis of mapping population lines using high throughput non-destructive imaging analysis in The Plant Accelerator
- Elemental analysis of mapping population lines
- Common molecular biological techniques including DNA and RNA extractions, cDNA synthesis, RT-PCR and PCR
- Molecular marker design

Key References:

Roy, S.J., Huang, W., Wang, X.J., Evrard, A., Schmöckel, S.M., Zafar, Z.U. and Tester, M. (2013) A novel protein kinase involved in Na^+ exclusion revealed from positional cloning. *Plant Cell Environ*, **36**, 553-568.
Roy, S.J., Tucker, E.J. and Tester, M. (2011) Genetic analysis of abiotic stress tolerance in crops. *Curr Opin Plant Biol*, **14**, 232-239.
Rajendran, K., Tester, M. and Roy, S.J. (2009) Quantifying the three main components of salinity tolerance in cereals. *Plant Cell Environ*, **32**, 237-249

Scholarship Available: Yes, $4,000 ACPFG Honours Scholarships are available (subject to conditions)* *Scholarships are competitive and are awarded principally on academic merit.*

Want to know more? Then contact stuart.roy@adelaide.edu.au *with the subject heading 'Honours Project', so that we can have a chat about the project in more detail.*

Honours Project Title: Identification of genes involved in cereal salinity tolerance

Supervisor(s): Dr Stuart Roy, Dr Delphine Fleury

Supervisor(s) Webpage(s): http://www.adelaide.edu.au/directory/stuart.roy
http://www.acpfg.com.au/profiles.php?linkid=20&profileid=6

Brief Project Outline: Salinity is one of the major factors limiting crop production in Australia. With the area of land affected by salinity increasing there is a demand to increase the salt tolerance of crop plants to maintain food security. Salinity tolerance in crop plants is often associated with an ability to minimise salt (primarily Na^+) accumulation the plant shoot. Research in model plant species, such as Arabidopsis and rice, has now identified a large range of genes encoding proteins which are involved in the transport of the Na^+ ion through a plant. Many of these genes encode ion transporters or channels which are responsible for transporting Na^+ into or out of a cell, or in the compartmentation of Na^+ in plant cell vacuoles. Other genes encode proteins involved in regulating the plant's response to salt stress, such as the calcium signalling pathways which controls a plant cell's response to salt, or proteins which control the activity of ion transporters/channels. While we know where these genes are in model plants, the location of their homologues in wheat and barley are unknown. Recent advances in the sequencing of the barley and wheat genome allows us to now identify the genomic location of these salinity tolerance genes on the chromosomes of wheat and barley. Such knowledge would be used to determine the best alleles for known salinity tolerance genes, which can then be used in traditional breeding or transgenic approaches to improve crop salinity tolerance. Genes identified by this approach will be correlated with known quantitative trait loci for salinity tolerance in wheat and barley mapping populations which will validated. This project will ideally suit an enthusiastic student who is interested in learning bioinformatics skills to analyse large genomes and in learning a range of molecular biology techniques.

Techniques/Skills Learnt:

- Bioinformatic skills, including sequence analysis, identification of homologous genes
- Common molecular biology techniques including RT-PCR, DNA and RNA extractions as well as DNA sequencing
- Molecular marker design
- Genetic mapping software
- Non-destructive phenotyping of wheat and/or barley

Key References:

Roy, S.J., Tucker, E.J. and Tester, M. (2011) Genetic analysis of abiotic stress tolerance in crops. *Curr Opin Plant Biol*, **14**, 232-239.
Roy, S.J. and Tester, M. (2012) Increasing salinity tolerance of crops, Avenues and Approaches In *Encyclopedia of Sustainablility Science and Technology* (Meyers, R.A. ed. New York: Springer.

Scholarship Available: Yes, $4,000 ACPFG Honours Scholarships are available (subject to conditions)* *Scholarships are competitive and are awarded principally on academic merit.*

Want to know more? Then contact stuart.roy@adelaide.edu.au or Delphine.fleury@acpfg.com.au *with the subject heading 'Honours Project', so that we can have a chat about the project in more detail.*