School of Agriculture, Food & Wine

Summer Scholarship Projects 2019/2020

Entomology & Plant Pathology

Project Title: *Design of biomimetic coatings to understand plant-pathogen relations*
Supervisor: Dr. Bryan Coad and Dr. Alan Little
E-mail: bryan.coad@adelaide.edu.au

Brief Project Outline:

Plant fungal pathogens have evolved highly sophisticated ways to infect crops and therefore are a threat to global food supply. On surfaces such as leaves, they first adhere to the surface and, interestingly, seem to know how to grow directionally towards ideal locations for infection before beginning surface penetration. If it were possible to better understand how the fungus senses and responds to the physical and chemical cues present on leaf surfaces, then we could develop strategies for interrupting infection, or develop plants which prevent adhesion or conceal inductive cues.

We propose that artificial surfaces can be constructed to model natural leaf surfaces. By designing surfaces with well-defined chemical and physical properties to which the fungus can respond, we will be able to understand the essential triggers for infection. Additionally, studying the adhesion on surfaces will allow us to understand how secreted chemicals prepare the surface before infection. The overall aim is to replicate essential components of the leaf and assemble these into a biomimetic model.

The goal of this research project is to make biomimetic surface coatings and investigate their biological response. This will involve using surface coating methods on materials such as glass slides, and to visualise the fungi using microscopy. This will provide an opportunity to learn about novel polymerisation techniques, characterisation of surfaces using surface analysis, and to visualise their biological effect.

Techniques/Skills Learnt:

- Surface coating techniques
- Surface analytical techniques
- Microscopy

Research Area: Biomaterials, interface science, bio-interfaces, plant-pathogen interactions.

Food & Nutrition

Project Title: *Liquid Chromatography−Tandem Mass Spectrometry Approach for Determining Monosaccharides and Glycosidic Linkages of Complex Carbohydrates*
Supervisor: Long Yu & Jelle Lahnstein, Research Fellow in Adelaide Glycomics
E-mail: long.yu@adelaide.edu.au

Brief Project Outline:
Carbohydrate is one of the most abundant and important biopolymers in nature, which possesses diverse biological functions and industrial applications. All these functions and applications depend on their intricate structures. However, the structural analysis of complex carbohydrates remains challenging mainly due to the lack of rapid analytical methods. The aim of this project is to establish a rapid and high-throughput method to determine and quantitate monosaccharides and glycosidic linkages of carbohydrate based on liquid chromatography−tandem mass spectrometry (LC-MS/MS). Firstly, we will prepare some monosaccharide standards with chemical derivatization, and run these standards using the established HPLC-method in our lab. After that, we will utilise these standards to set up the LC-MS/MS methods based on the published paper, and optimise the conditions. Finally, we will use the new LC-MS/MS methods to analyse some complex polysaccharides, *e.g.* Gum Arabic. The output of this project will deliver a new platform of structural analysis of carbohydrate to other relevant projects, including ARC discovery projects and projects of Fight Food Waste CRC centre. Moreover, it will also be a great opportunity for the successful candidate to learn basic theory of carbohydrate chemistry and advance analytical techniques, especially mass spectrometry.

Techniques/Skills Learnt:
- Sample preparation, and carbohydrate chemistry
- High Performance Liquid Chromatography (HPLC)
- Diode array HPLC detectors (DAD)
- Triple quadrupole mass spectrometry (QQQ)
- Other analytical techniques available in Adelaide Glycomics

Project Title: *Food Retail Industry Compliance with Labelling and Information Requirements*
Supervisor: Helen Morris
E-mail: helen.morris@adelaide.edu.au
Location: Charles Hawker Building, Waite Campus
This project is open to 1 – 2 students

Brief Project Outline:

The Australia New Zealand Food Standards Code sets out the labelling and information requirements for food that is for retail sale. It is the responsibility of food businesses to ensure that labelling of their retail products complies with the requirements of the Code.

Food and Nutrition Science students examine food labels during their Nutrition Tutorial classes. A small number of the food labels examined in 2019 were found to be not fully compliant with labelling and information requirements.

This project aims to examine a sample of labels taken from current food products for retail sale and to consider the level of compliance of these labels with the requirements set out in the Code.

To find out more about this project please contact Helen by email.

Techniques/Skills Learnt:

- The application of food labelling and information requirements to food that is for retail sale, as set-out in the Australia New Zealand Food Standards Code.
- Reading food labels
- Collection of data and entry into an Excel spreadsheet
- Analysis of data against a set of standards
- Communication of project outcome/s

Plant Genetics, Genomics & Breeding

Project Title: *Identifying gene knockouts in wheat and functional genomics*
Supervisor: Ken Chalmers
E-mail: ken.chalmers@adelaide.edu.au

Brief Project Outline:

TILLING (Targeting Induced Local Lesions IN Genomes) is a non-transgenic approach for functional genomics and crop improvement, based on mutagenesis followed by focused screening. In some Australian wheat the root lesion nematode resistance gene (*Rlnn1*) sits next to an unwanted gene for flour colour (*Psy-A1*). This gives wheat flour a yellowness that is not wanted in bread making. The genes come from a wild wheat which means that normal 'genetics-based' breeding cannot separate them. Using a genomics approach we can knockout the flour colour gene while leaving the resistance gene intact. By sequencing the mutated lines and developing genetic markers it will be possible to identify the knocked out gene.

Techniques/Skills Learnt:

- DNA sequence analysis
- Primer design
- Bioinformatic gene analysis
- Functional genomics

Project Title: *Tolerance of chickpea wild relatives to high levels of boron*
Supervisor: Dr Julie Hayes (University of Adelaide) and Dr Judith Atieno (SARDI)
E-mail: julie.hayes@adelaide.edu.au

Brief Project Outline:

As for other temperate grain crops, chickpea production in Australia is affected by high levels of soil boron (B) in some growing regions. Soil B toxicity commonly occurs where there is also dryland salinity, and includes parts of the Victorian and South Australian Mallee, and across the Eyre and Yorke Peninsulas. Screens of chickpea germplasm have so far failed to identify any genetic variation for tolerance to B toxicity. This has been a significant bottleneck for Australian breeders. However, wild relatives of other crop types are often a useful source of novel alleles for tolerance to abiotic stresses and recently, new collections of wild *Cicer* material have been made available to breeders and researchers through the Australian Grains Genebank (AGG). The student will assess B tolerance in accessions of *Cicer reticulatum* and *C. echinospermum*, using an established hydroponics system in the greenhouse. Tolerance to high B will be determined by assessment of leaf symptoms, shoot and root growth relative to a low B treatment, and possibly ICP analysis for B concentration in whole shoots. Tolerance will be compared to that for the standard chickpea cultivars PBA HatTrick, PBA Slasher and Kyabra, which have been used as parents in developing F_2 populations with selected wild *Cicer* accessions. Depending on the outcome of the summer project, these populations could become a valuable resource for studying the genetics of B toxicity tolerance in chickpea.

Techniques/Skills Learnt:

- Experimental design and analysis
- Basic plant nutrition, hydroponics experimentation, plant genetics
- The student will work with researchers from both the University of Adelaide and the South Australian Research and Development Institute (SARDI) for this project, and will have the opportunity to also be involved in other ongoing research areas.

Plant Physiology Viticulture & Horticulture

Project Title: *Assessing vineyard and grapevine water status using UAV (drone)-based remote sensing and machine learning.*
Supervisor(s): Dr Deepak Gautam, Dr Vinay Pagay
E-mail(s): deepak.gautam@adelaide.edu.au, vinay.pagay@adelaide.edu.au

Brief Project Outline:
Assessment of grapevine water status is critical for efficient irrigation scheduling and traditionally performed using ground-based measurements of individual vines; this approach is destructive, cumbersome, and expensive. This project aims to replace ground-based vine water status measurements with high-resolution UAV-based measurements that would enable rapid and non-destructive mapping of vine water status across a larger region with increased efficiency. For this purpose, data relating to vine structural properties, phenological stage, thermal response, spectral response, and meteorological data will be used to assess vine water status. Machine learning-based predictive models may help in robust and efficient estimation of vine water status from aerial imagery. This project would be of relevance to students interested in agritcultural technology, irrigation management, proximal and remote sensing, and modelling in any cropping system.

Techniques/Skills Learnt:
- Various aspects of UAV operations for remote sensing data collection in vineyards.
- Ground-based plant water stress measurement techniques.
- Gain familiarity with the processing of aerial images to generate spatial maps.
- Assist with the development of predictive models, based on remote sensing data and machine learning (AI), to assess vine water status.

Project Title: *Acetate-based biostimulant for drought stress in plants*
Supervisor: Mamoru Okamoto
E-mail: mamoru.okamoto@adelaide.edu.au

Brief Project Outline:
Plants have defence mechanisms against abiotic/biotic stresses, and jasmonate (JA) signalling network is one of them. Drought stress triggers plants produce acetate which stimulates JA synthesis. Interestingly, external application of acetate enhances drought tolerance in plants (Kim et al., 2017). In this project, student(s) will study the efficacy of an acetate-based biostimulant in plants. Key activities are 1. Optimisation of biostimulant application and 2. Development of diagnostic biomarkers for “stimulated” plants.
Kim, J.-M., et al. (2017). Acetate-mediated novel survival strategy against drought in plants. Nature Plants 3, 17097.

Techniques/Skills Learnt:
- Hydroponic systems
- Biochemical assays
- RNA extraction and gene expression analysis

Project Title: Identifying molecular signatures of mobile RNA transcripts in grapevine
Supervisors: Rakesh David, Sunita Ramesh, Steve Tyerman
E-mail: **rakesh.david@adelaide.edu.au**

Brief Project Outline:

Throughout their life cycle, plants are exposed to a wide range of environmental conditions that change dynamically over time and often in an unpredictable manner. In order to survive, plants have evolved signaling mechanisms to communicate between distantly located tissues such as root to shoot and vice versa. Emerging evidence has pointed to RNA as an important long-distance intercellular signaling molecule in plants. However, very little is known about the factors that govern mobility of the RNA signal.

Using next generation sequencing data in grapevine (*Vitis vinifera* cv. Shiraz) and a custom-built bioinformatics pipeline, we have previously identified a number of putative RNA transcripts that contain molecular signatures that are indicative of intercellular movement. The aim of this project will be to confirm the presence and movement of these candidate transcripts in grafted grapevine plants combining two genetically distinct varieties. To achieve this aim, variety specific single nucleotide polymorphisms (SNPs) will be used as diagnostic markers to identify mobile RNA transcripts.

The project will be undertaken at the Centre of Excellence in Plant Energy Biology (https://www.plantransig.com/), Waite campus and will be supervised by the Rakesh David, Sunita Ramesh and Steve Tyerman from the School of Agriculture, Food and Wine.

If you are interested in learning molecular skills such as PCR, SNP analysis and applications in NGS technology, please contact rakesh.david@adelaide.edu.au to discuss this opportunity further.

Techniques/Skills Learnt:

- Handling of Next Generation Sequencing data sets
- RNA and genomic DNA extraction
- Quantitative and semi-quantitative PCR RT-PCR
- *In silico* SNP analysis
- Knowledge about RNA biology and systemic long-distance movement in plants