**Report from the 11th IPMB 2015 conference, Iguazu Falls, Brazil.**

The GCRI Trust, who promote scientific research and education on the cultivation of protected crops, generously awarded a travel grant to help fund Stephen Jackson’s attendance at the 11th International Plant Molecular Biology (IPMB) conference.

The IPMB conference is held once every 3 years and being one of the major conferences in this field it attracts high profile plant biologists working at the cutting edge of their research area to talk about their work. This year the keynote presentations were particularly impressive, especially that of Prof Magnus Nordberg from the Gregor Mendel Institute in Austria, who talked about ‘The Genetic Basis of Adaptation’. He discussed the fact that whilst Genome-Wide Association Studies (GWAS) have been used very successfully to identify and map DNA sequence differences (eg. single nucleotide polymorphisms, SNPs) that have major effects on phenotype, GWAS is not able to identify the many small phenotypic effects caused by specific sequence differences which can account for up to 90% of the overall phenotype. Although the individual effects of these ‘small effect’ sequence differences are difficult to detect on the phenotype of the plant, they can still be acted upon by natural selection because the timescale and population size is so large, thus they can start to accumulate gradually and result in a large overall cumulative effect on the phenotype of the plant. This is analogous to the cumulative effect of small effect QTLs however in this case he was talking about much smaller (many undetectable) phenotypic effects resulting from known changes in the DNA sequence rather than large areas of the chromosome defined by co-segregating genetic markers.

It is now widely accepted that as genome sequencing is becoming so cheap and readily accessible, and because sequencing provides so much more information, continuing to work with genetic markers is becoming less worthwhile. With this being the case ‘Divseek’ is a timely new initiative from the Global Plant Council (GPC). The GPC (<http://globalplantcouncil.org/home>) is a coalition of national, regional and international societies representing plant, crop and agricultural and environmental sciences across the globe. One of the aims of the GPC is to facilitate science-based initiatives that will help close the gap between basic research and applied innovations, hence the Diversity seek (‘Divseek’) initiative. This initiative aims to make much better use of the extensive genetic diversity that exists in crop genebanks around the world and which is seen as a huge under-used resource (the quoted example was that only 6% of the available diversity in rice has been used in commercial varieties). There are over 7 million accessions in 1,750 genebanks around the world, however many of these accessions have not been characterized. In order to mobilise all this diversity this initative will perform high throughput geneotyping and phenotyping in order to identify useful diversity in a range of crops (which crops in particular was not mentioned). In addition the aim is to make these resources more accessible by forming common data standards and legal frameworks for accessing and sharing the data/germplasm.

Many sessions at this conference focused on increasing our understanding of the role of epigenetics in heritable traits. Epigenetic inheritance occurs much more in plants than it does in animals, and the evolution of the mechanisms controlling epigenetic inheritance in plants was the subject of a presentation by Rob Martienssen from Cold Spring Harbour, USA. Epigenetic mechanisms involve the expression of microRNAs which cause changes in histone methylation and chromatin structure, resulting in effects on levels of gene expression and thus phenotype. These effects are influenced by the environment and are heritable even though they do not involve changes in DNA sequence of genes. Thus two identical gene sequences (eg. in cloned, or vegetatively propagated plants) can have different levels of expression which may result in phenotypic differences between the plants.

Perhaps the sessions that would be of most interest and relevance to members of the GCRI Trust are those that described recent advances in plant biotechnological approaches such as in Gene Editing and Plant Nanotechnology. These approaches are likely to become widely used in both plant breeding and plant growth regulation in the future.

Gene editing means making changes to an endogenous gene in a plant cell which can alter the function or expression of the protein that it encodes. This is much better than introducing a gene from another plant or organism as is currently the case with transgenic plants. The technique uses an enzyme that is directed to a user-defined target sequence in the genomic DNA (eg. a specific sequence in a gene of interest) where the enzyme makes a cut in the DNA. The cell then tries to repair this cut but often doesn’t repair the cut properly, thus nucleotides can be added or lost at the repair site which introduces a mutation into the gene. Cells carrying this mutation can then be used to regenerate a new plant. At the basic level this technique can be used to target and mutate any specific gene of choice thus inactivating them. The poster I presented at the conference gave an example of this as it described our use of a particular gene editing technology called CRISPR to mutate a key flowering gene (*FLOWERING LOCUS T*) and thus create late flowering plants (see attached). At a more advance level a gene sequence can be modified quite substantially. Two cuts can be made in a gene to delete a whole section of sequence and if a substitute sequence is provided then this can be swopped in to change the gene sequence. Such changes could alter the activity or specificity of enzymes or transcription factors. The huge potential of gene editing approaches are obvious and it is destined to become a widespread approach in breeding of agricultural and horticultural crops, plant breeding companies are already investing heavily in this research area. Talks at the conference described gene editing in a range of crop plants including potato, wheat, soybean and sugarcane. In the near future it will become much quicker to introduce a beneficial allele into a commercial breeding line by using gene editing to change the existing allele in that line into the desired one rather than going through a lengthy crossing and back-crossing programme.

The Plant Nanotechnology session included talks on using different types of carbon or silica nanoparticles. These nanoparticles are small enough to go through pores in plant cell walls and membranes and are readily taken up into plant cells. They can penetrate the seed coat (charged carbon nanotubes), or can be administered through the roots and get distributed throughout the plant by the transpiration stream. They are very stable, and also hollow/porous so that they can hold a variety of compounds which can thus be delivered to and taken up by the plant. David Cahill from Deakin University, Australia, described his work in using silica nanoparticles to deliver the hormone salicylic acid (SA) into plants, this hormone is involved in helping plants cope with stresses such as pathogen attack. He designed nanoparticles with ‘gatekeepers’ that seal the SA inside the nanoparticles until a particular signal was perceived. In this case the signal was glutathione which is upregulated in plant cells under stress conditions. In this way he was able to achieve regulated delivery of SA just in the cells that were experiencing the stress. Apart from hormones, other talks described the use of nanoparticles to deliver small proteins and even nucleic acids, so the possibilities for their use are very wide-ranging. Silica nanoparticles have no phytotoxic effects on the plant, and are already widely used in soaps and cosmetics therefore human health concerns are thought to be negligible (but still need to be tested for consumption of plants treated with nanoparticles). Whilst this technology is still at the experimental stage, one company has started to produce nanoparticles commercially and so we can expect an explosion in their potential application and use within the next 5 years.

I would like to express my gratitude to the GCRI Trust for the travel award that helped me attend this very interesting and worthwhile conference.