THE UNIVERSITY OF SYDNEY

Australian Government
Australian Centre for International Agricultural Research

Mitigating the effects of stripe rust on wheat production in South Asia and Eastern Africa

ACIAR Project: CIM/2014/081 News Letter No. 1, 2017

ACIAR funded research project "CIM/2014/081" is coordinated by the University of Sydney in collaboration with partner organisations from Ethiopia, India, Nepal and Pakistan. The project aimed to reduce the vulnerability of wheat crop to stripe rust in South Asia (SA) and Eastern Africa (EA) was officially launched on 27th February 2017 in Dubai by the project team: Dr. Eric Huttner, Prof. Robert Park, Dr. Davinder Singh and Dr. Karanjeet Sandhu from Australia, Dr. Fentahun Mengistu and Dr. Bekele Hundie from Ethiopia, Dr. G.P. Singh, Dr. Ravish Chatrath and Dr. Subhash Bhardwaj from India, Dr. Baidya Nath Mahto and Dr. Dhruba Bahadur Thapa from Nepal and Dr. Anjum Munir, Dr. Atiq Rattu and Dr. Munawar Raza Kazmi from Pakistan.

It is anticipated that benefits will begin to flow by project completion, with maximum impact being reached after about 10 years. Overall benefits will be realised principally by a reduction in epidemics of wheat stripe rust or wheat yellow rust (WYR), increased productivity and low or even no use of fungicides resulting in safer food for consumers, safer workplaces and a cleaner environment. To give some idea of the value of this approach, it was estimated in 2009 that genetic protection from WYR in Australia returns some $431 million annually.

Meet our team

Australia:

Project Leader

Prof. Robert Park
Director, Cereal Rust Research
PBI, University of Sydney

Research Program Manager

Dr. Eric Huttner
Research Program Manager
ACIAR, Australia

Co-Project Leader & Collaborating scientist

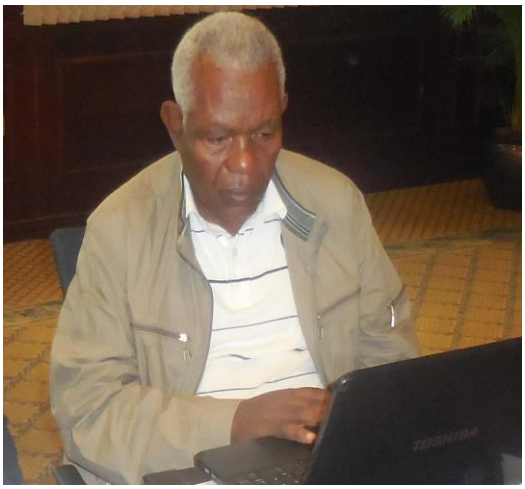
Dr. Davinder Singh
Senior Research Scientist
PBI, University of Sydney

Project manager & Collaborating scientist

Dr. Karanjeet Sandhu
Wheat Rust Pathologist
PBI, University of Sydney

Ethiopia:

Dr Fentahun Mengistu
Director General
Ethiopian Institute of Agricultural Research



Dr Bekele Hundie
Cereal Rust Pathologist
Ethiopian Institute of Agricultural Research

India:

Dr. G.P. Singh
Director
Indian Institute of Wheat and Barley Research

Dr. Ravish Chatrath
Principal Scientist (Plant Breeding)
Indian Institute of Wheat and Barley Research

Dr. Subhash Bhardwaj
Principal Scientist & Head
Regional Station, Flowerdale, Shimla
Indian Institute of Wheat and Barley Research

Nepal:

Dr. Dhruba Bahadur Thapa
Wheat Breeder
Nepal Agricultural Research Council

Dr. Baidya Nath Mahto
Principal Scientist
Plant Pathology Division
Nepal Agricultural Research Council

Pakistan:

Dr. Anjum Munir
Senior Director
Crop Diseases Research Institute
Pakistan Agricultural Research Council

Dr. Atiq Rattu
Director/National Coordinator Wheat
Plant Sciences Division
Pakistan Agricultural Research Council

Project inception meeting

Scientists from Australia, Ethiopia, India, Nepal and Pakistan met in Dubai on 27th and 28th February 2017and discussed a work-plan to achieve different milestones of the project. Discussion points included the assembly of a core set of 250 elite wheat genotypes representing all partner countries, characterisation of stripe rust resistance, selection of parents for the development of Nested Association Mapping (NAM) populations and germplasm enhancement. It was principally agreed that each partner country will send top 50 selected wheat genotypes to Australia for "Core Set" assembly, rust screening and seed increase for cross testing and selections for rust resistance under different environments of SA and EA. Australian scientists proposed the elite minor gene donors for the development of Near Isogenic Lines (NILs) and discussed the use of minor gene combination stocks in developing new tools for stripe rust surveillance. Two young scientists each from Ethiopia, India, Nepal and Pakistan will participate in rust pathology and genetics training at the Plant Breeding Institute (PBI) Cobbitty.

Front row L to R: Dr. G.P. Singh, Dr. Fentahun Mengistu, Dr. Ravish Chatrath, Dr. Subhash Bhardwaj, Dr. Baidya Nath Mahto, Dr. Davinder Singh, Dr. Dhruba Bahadur Thapa and Dr. Karanjeet Sandhu

Second row L to R: Dr. Bekele Hundie, Dr. Eric Huttner, Dr. Anjum Munir, Dr. Munawar Raza Kazmi and Prof. Robert Park

The meeting was concluded on a positive note when Prof. Robert Park presented the delegates with Australian icon "Boomerang". "Bou-mar-rang" means a returning throw stick, believed to be invented by the Turuwal people in Australia during 1822 though rock paintings indicate that it could be 50,000 years old. Boomerang comes back when thrown and used as a hunting weapon and as a toy as well.

Hopefully "Bou-mar-rang" will make us remember to continue our efforts to curb WYR menace by using the weapon of our knowledge and "**a critical appraisal of the effectiveness of known and unknown minor gene resistance to stripe rust across different regions**"

The Boomerang

PLANT BREEDING INSTITUTE, COBBITTY, NSW, AUSTRALIA

THE UNIVERSITY OF SYDNEY

The Boomerang

Team's vision and research objectives

Research team's long term vision is to reduce vulnerability of wheat crop to *Puccinia striiformis* f sp. *tritici* (*Pst*) in the South Asian, East African and Australian epidemiological regions through research undertaken by a group of scientists working within a collaborative network of key cereal improvement centres, with a sound knowledge-base of rust variability and host resistance within these epidemiological zones.

Research objectives: were formulated in line with the framework outlined in the ACIAR Strategic Plan 2014-18, with a research focus on crop improvement.

1. Characterize resistance to *Pst* in wheat germplasm in partner countries:

- Off-shore field testing of wheat germplasm with *Pst* (supplemented with greenhouse and field testing in Australia).
- Rust resistance gene postulation based on phenotypic and molecular marker screens.
- Genetic analysis of WYR resistance using populations developed within the project and by association mapping of a panel of the most important wheat genotypes in SA and EA.
- Identification of markers linked to new gene/s for resistance, for use in Marker Assisted Selection (MAS).

2. Validation of minor gene combinations and refinement of markers:

- Development of NAM population (F4) based on elite minor gene donors and 4 reference cultivars selected to represent EA and SA.
- GBS genotyping of the NAM population and phenotyping in all partner countries to generate the data needed and to select the most promising lines for use in national breeding programs.

3. Undertake stripe rust pathogen surveillance:

- Training in rust surveillance (wheat and barberry), including sample collection and processing.
- Race analysis, in-country with technical backstopping from Global Rust Reference Centre, Denmark, including preservation of important *Pst* isolates in each partner country for use in future pre-breeding activities.
- SSR genetic fingerprinting (at PBI) of *Pst* isolates collected annually in participating countries.
- Development of new diagnostic tools for *Pst* based on either DArT-seq technology or SNP chip technology to allow assessments of the degree of genetic diversity and mechanisms driving pathogen evolution.
- Development of NILs set to complement the current Avocet NILs series, to allow precise assessments of pathogen virulence for minor genes of *Pst* resistance.

4. To build partner countries capacity in rust pathology and genetics:

- Five months training in Australia for up to 8 young junior scientists from partner countries.
- Visits to help in rust survey and race analysis.

5. Project management:

- Conducting project meetings and coordination.
- Newsletters and progress reports for communication and information dissemination.
- Financial managements for research expenses and other activities.
- Liaison with partner countries and funding body ACIAR.

Research impacts and benefits

This research project will deliver outputs that are aligned with priorities articulated in the ACIAR's Strategic Plan, including new tools to increase the speed with which improved wheat cultivars are developed, new knowledge of rust resistance in wheat and of rust pathogen variability, and increased capacity in all partner countries. The project also includes research to characterise the stripe rust pathogen itself and to determine if and how it migrates within SA and EA. Part of this research will assess the potential of the pathogen to overcome or at least erode putative sources of durable resistance to WYR.

The planned work will contribute to poverty alleviation through the sustainable control of WYR, which will in turn help and to stabilize wheat yields. Future economic benefits are expected from the research results when implemented in SA and EA once the project outputs are realised. A successful wheat crop can bring income for farmers, millers and flow-on benefits to cereal consumers in each country. Discovery and deployment of stripe rust resistance genes alone or in combination with other durable genes will allow the development of cultivars with high levels of durable rust resistance, which will reduce the use of fungicides. It is expected that such reductions will reduce chemical residues and lower the risks posed by these chemicals to the health of humans and other animals. Reduced or no use of fungicides will result in environment friendly wheat production and safer food for consumers. Though maximum impact and full benefits of research will be extended after about a decade, nonetheless, we also anticipate some impacts to begin to be seen in the next 12 to 24 months.

Ultimately, research will contribute to more sustainable and productive wheat production, benefitting all partner and Australian stakeholders especially via increased preparedness for potential future incursions of WYR.

Progress

Delays with contract negotiations and finalising the signatures by the partner countries resulted in the delayed start of project on 1st January 2017. Despite this, we were able to initiate some research activities in 2016. In Dubai meeting, perspectives of the teams from partner countries on their participation and expectations from the research project partnership, their long-term vision for the project outcomes and implementation of research findings and the current situation of WYR in each country were discussed. Research project was discussed in detail and agreement reached on timelines for all activities. It was principally agreed to assemble a core set of 250 wheat genotypes that includes the most adapted 50 wheat cultivars from each country. Parents for the development of the NAM populations, and elite minor gene donors for NILs were discussed and finalised.

From L to R: Mr. Andrew McIntosh and Mr. Matthew Williams inspecting spreader lines for rust infections

The Core set of wheat genotypes was assembled, and sown in the field at PBI, Cobbitty. Some additional lines imported from Nepal are currently growing under quarantine conditions at PBI and will be released towards the end of 2017. The development of genetic resources for the project, research populations and genetic stocks for monitoring the effectiveness of resistance in different environments, is now well underway. Crossing to initiate the development of the NAM population and NIL stock development has progressed with and some F1s already in hand. Initially, a range in the maturity timings of certain parental genotypes was a problem in crossing, which was resolved by using growth rooms developed with funds from the project to coincide growth stages. Rust phenotyping and marker assisted selection of BC_1F2_s is under progress for the next cycle of backcrossing required to develop NILs stocks carrying minor genes for stripe rust resistance.

Field sowing: Wheat germplasm sown at Horse Unit field site, PBI Cobbitty

Nominations of trainees from each partner country; Ethiopia, India, Nepal and Pakistan have been received and the final list is being decided, with the first cohort of trainees expected to start training at PBI in early 2018. Each of the trainees will then assist in-country germplasm screening to support local cereal breeding programs, in-country rust race analysis and the generation and maintenance of pure inoculum of important rust races for use in field selection nurseries.

Crossing: F1s maturing in a growth room at PBI, Cobbitty

Finally on behalf of "CIM/2014/081" team
we congratulate **Dr. Baidya Nath Mahto**
for receiving **"Suprabal Jansewashree Bibhushan Award"**

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