CAIGE Project 2013-2018
Enhanced delivery of CIMMYT germplasm to Australia:

Wheat Germplasm sent in 2015
Elite lines sent to Australia in 2015

- 280 entries
- Candidates for forming 37th ESWYT, 24th SAWYT and 15th HTWYT
- Derived from 202 different crosses
- Grain yield performance data from Cd. Obregon 2013-14 (1 environment) and 2014-15 (6 environments), agronomic, disease resistance and quality used in selecting the entries
- 3rd year yield performance testing in Cd. Obregon 2015-16 season in 3 environments
Elite lines sent to Australia in 2015 - Data

- 1\textsuperscript{st} year (Obregon 2013-14) grain yield performance data from optimally irrigated- bed planting
- 2\textsuperscript{nd} year (Obregon 2014-15) grain yield performance data from six environments (optimally irrigated- flat & bed plantings; high & intermediate drought stress; early and late sown heat stress)
- Agronomic data- heading, maturity, height, visual scoring
- Phenotypic data for stem rust (Ug99) along with gene postulation, Yellow Rust (Mexico, Kenya, India), Leaf Rust, Septoria tritici, Spot Blotch, Fusarium Head Scab (FHB), Karnal Bunt
- Kernel weight, Test weight & detailed end-use quality data
- GBS marker data also available and can be provided on request

Next slides give summary of selected traits
Leaf rust resistance for 142 entries with adult plant resistance & 138 with race-specific genes (Mean disease severity El Batan 2014 and Obregon 2014-15) (Data recorded when leaves of susceptible checks became necrotic due to leaf rust)

High levels of leaf rust resistance and no difference in leaf rust severity distribution for entries with APR versus R-genes
Yellow rust responses in field at Celaya, Mexico (2014-15) of 147 entries with seedling susceptibility and 133 entries with seedlings resistance with an aggressive Yr27+ Yr31 virulent Mexican isolate Mex14.191

(Data recorded when leaves of susceptible checks became necrotic due to yellow rust)

High proportion of entries show a high level of resistance in field irrespective of seedling reaction with the same race
Ug99 stem rust resistance for 244 entries with adult plant resistance & 36 with race-specific genes (Mean disease severity Njoro, Kenya during 2014 and 2015 off and main seasons)

(Final data recorded when susceptible checks became necrotic due to stem rust)

Several entries possess high to adequate adult-plant resistance to Ug99 race group
A high proportion of entries show high to moderate resistance. Sources of resistance are diverse, including synthetic wheats and mostly quantitative.
Karnal bunt resistance in 280 entries, Cd. Obregon 2014-15 (two sowing dates)

Quantitative variation for resistance, low frequency of entries show good resistance
TKW, loaf volume and end-use quality (CIMMYT classification) of entries grown under optimally irrigated environment in Obregon 2013-14 & 2014-15

- More entries with higher TKW and high loaf volumes
- Most entries either good for industrial or flat bread products (quality types 1a, 1b, 2a, 2b, 3a, 3b).
- Very significant reduction in tenacious wheat types (quality type 5) in new germplasm (<5% entries)
Conclusion

• Exchange of germplasm and information is going well under CAIGE project
• Progress towards enhancing grain yields under irrigated, drought and heat stress environments is evident
• Good progress in building APR to Ug99 stem rust. New diversity for race-specific resistance genes also incorporated.
• Stripe rust, leaf rust and resistance to various leaf spotting diseases significantly enhanced
• End-use quality improved in new germplasm, which should aid the utilization of CIMMYT germplasm by Australian breeding programs
“Focused Improvement of Durum Wheat Germplasm from CIMMYT for Yield Potential, Drought and Biotic Constraints”

A GRDC, Australia – CIMMYT Project
2015-2018

Karim Ammar (k.ammar@cgiar.org)
Head, Durum Wheat & Triticale Breeding
Global Wheat Program
International Maize & Wheat Improvement Center
Mexico
Project Outputs

*Germplasm relevant to Australian durum environments*

- **Output 1: 150 lines annually**
  - Improved yield potential and drought tolerance
  - Resistant to Mexican races of leaf and yellow rust
  - Some resistant to Ethiopian races of stem rust

- **Output 2: Breeding stream made more relevant to Australian conditions:**
  - **50 crosses** annually between Australian lines (designated by Australian breeders) and best CIMMYT elite material
  - Selection until F3/F4
  - Bulks sent to Australia for continued selection

- **Output 3: Delivery of all outputs through CAIGE**
  - Seed from outputs 1 + 2
  - Information on germplasm from output 1
Output 1: Germplasm delivery
150 of the program’s best lines, annually

- **2014:**
  - 150 F₉ bulks (30 grams each) sent to CAIGE
  - Went through quarantine & increase in Australia
  - Are now in trials in Australia
  - Already evaluated for SBP at CIMMYT Turkey by Amer

- **2015:**
  - 150 F₁₀ bulks (20 grams each) sent to CAIGE
  - Currently under quarantine?
  - Just provided to Amer for SBP evaluation

**Selection criteria:**
- Good yield potential: 2 years of testing under full irrigation *(6.0-8.5 t/ha)*
- Good drought tolerance: 1 year testing under drip-simulated drought *(2.0-2.5 t/ha)*
- Maintenance of good kernel weight under drought
- Complete resistance to leaf & yellow rust: 4 cycles of testing as fixed lines under artificial inoculation
- Strong gluten + acceptable-to-outstanding yellow color
### Crosses

<table>
<thead>
<tr>
<th>Cross type</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simple</td>
<td>Top</td>
</tr>
<tr>
<td>Australia x CIMMYT Elite</td>
<td>175</td>
<td>21</td>
</tr>
<tr>
<td>Soil-Borne Pathogens*</td>
<td>327</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>502</td>
<td>21</td>
</tr>
</tbody>
</table>

*: Amer's Project, CIMMYT-Turkey

### Breeding stream as of Obregon cycle 2016

<table>
<thead>
<tr>
<th>Original cross type</th>
<th>F\textsubscript{1,simple}</th>
<th>F\textsubscript{1,TOP/DUOOLE}</th>
<th>F2 populations</th>
<th>F4 populations\textsuperscript{1}</th>
<th>F6 Lines\textsuperscript{2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia x CIMMYT Elite</td>
<td>76</td>
<td>146</td>
<td>242</td>
<td>51</td>
<td>74</td>
</tr>
<tr>
<td>Soil-Borne Pathogens*</td>
<td>.</td>
<td>38</td>
<td>72</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>*: Amer's Project, CIMMYT-Turkey</td>
<td>76</td>
<td>184</td>
<td>314</td>
<td>51</td>
<td>74</td>
</tr>
</tbody>
</table>

\textsuperscript{1}: F4 selected bulks from crosses made prior de official start of project

\textsuperscript{2}: F6 lines from crosses made prior de official start of project, 4 purification head-rows + PYT
Output 3: Information delivery
Populating CAIGE database with all available data on material sent

- Data available for germplasm delivered in 2014:
  - 3 years of testing under full irrigation
  - 2 years of testing for drought tolerance
  - 1 year of testing for heat tolerance
  - 6 cycles of testing for Leaf & Yellow rust
  - 1-2 cycles of testing in Ethiopia for stem rust

- Data available for germplasm delivered in 2015:
  - 2 years of testing under full irrigation
  - 1 year of testing for drought tolerance
  - 4 cycles of testing for Leaf & Yellow rust
  - 1 cycles of testing in Ethiopia for stem rust

- Compilation of all information in process for delivery to CAIGE, soon.
Future Research

Based on mutual interests of Australian programs and CIMMYT

- **Needs defining very soon:**
  - During visit to Obregon
  - Finalized by next fall CAIGE meeting
  - Many populations, genetic stocks available for research

- **Areas of interest of CIMMYT-Mexico (not exclusive):**
  - Widening genetic basis of rust resistance
  - Drought tolerance
  - Heat tolerance

- **See you soon in Obregon !!!**
Identification and Utilization of Novel Sources of Resistance to Crown Rot and the Root Lesion Nematodes in Adapted Spring and Durum Wheat

Dababat et al.
MAJOR OBJECTIVES

◆ Identify dryland Crown Rot (*F. culmorum*) and/or root lesion nematodes (*P. thornei* and *P. neglectus*) resistant *spring bread wheat* germplasm with high yield potential

◆ Identify dryland Crown Rot (*F. culmorum*) and/or root lesion nematodes (*P. thornei* and *P. neglectus*) resistant *spring durum wheat* germplasm with high yield potential

◆ Develop appropriate markers to understand the genetic basis and mechanisms of resistance against specific SBPs in collaboration with Australian wheat community as well as the International community.

◆ Deliver germplasm with multiple resistances against SBPs to the Australian wheat community through the CAIGE platform

◆ NARs capacity building
ACHIEVEMENTS

◆ From 169 SW lines screened for resistance to SBP, 50 and 29 lines were selected and planted in yield (tolerance) trials for CR and RLN-Pt in 2016 respectively.

◆ 211 durum wheat germplasm were screened against (*F. culmorum*) under greenhouse, growth room and field conditions. Also screened for RLN (*P. neglectus* and *P. thornei*) under growth room conditions. Of the tested, 50 lines were selected and planted in yield (tolerance) trials in 2016 for Cr and Pt.

◆ Crosses of **DW CIMMYT x DW Australia** and **SW CIMMYT X SW Australia** being developed at Mexico DW & SW breeding programs (F4)

◆ Follow up with **SAGI** to improve trial design and data analysis

◆ 235 Australian Wheat Germplasm collection sent by CAIGE to SBP to be screened in 2016.
◆ 13 lines - out of the 30 lines of the CRI project - were tested under ± Cr infestation to evaluate their yield potential (Tolerance) in Yozgat, Konya, and Eskisehir in 2015. The best performing were:

1) **EGAGREGORY///CROC_1/AE.SQUARROSA**
   
   (224)//OPATA/3/PASTOR - (PBICR-07-007-#51)

1) **LANG//WBLL1*2/TUKURU** (PBICR-07-009-#4)
Yield of DBA S4 lines under CR disease pressure - 2014

LSD = 0.15 t/ha

Rated “S”
New SVS release
SEEDS SENT TO AUSTRALIA - 2015

Germplasm delivered to Australia via CAIGE project with multiple disease resistance under the frame of the GRDC Project (CIM00014) in 2015

◆ The list of material (11 SW and 13 DW) identified as being resistant to Cr and/or RLN from the 2014 screening are ready to be distributed to collaborators in Australia. The list and associated trait date is available on CAIGE website (S. Micallef)


◆ The following seeds were send to Australia via CAIGE Project in 2015: Durum Wheat (24 lines) & Spring Wheat (39 lines)

◆ 17 F1 generated by crossing the Turkish landraces with the Australia spring wheat recommended lines. The F1 seeds were sent to prof Richard Trethowan for further development.
FUTURE RESEARCH PLAN

◆ **200 SW** and **210 DW** lines were received from Mexico and are being screened in 2016.

◆ A set of **202 SW** lines phenotyped for (RLN and Cr) and genotyped. Association mapping will be done using GBS data.

◆ A set of **229 DW** lines phenotypes for (RLN and Cr). Genotypic data will be performed at the Cukurova university.

◆ **235** Australian Wheat Germplasm collection sent by CAIGE to SBP program to be screened. This material includes seed from USQ (LRC), US, EdStar Genetics, Intergrain & AGG. They are planted in field for seed increase.

◆ Understanding **mechanisms of resistances** to Cr (both Culmorum and Pseudograminearum), and lesion nematodes (RLN-Pt and RLN-Pn) in collaboration with Australian partners identified.
Comparison of the growth patterns of two crown rot causing pathogens in wheat

PhD Candidate: Joseph Barry – Uni Southern Queensland

Principal Supervisor: Prof. Mark Sutherland (USQ)
Associate Supervisors: Dr. Cassy Percy (USQ)  
Dr. Noel Knight (USQ)

Collaborators: Dr. Amer Dababat (CIMMYT) 
Dr. Gul Erginbas (CIMMYT) 
Dr. Julie Nicol (CIMMYT) 
Dr. Grant Hollaway (DEDJTR) 
Melissa Cooke (DEDJTR)
Crown rot of wheat

• Two species of fungi, *Fusarium pseudograminearum* (*Fp*) and *Fusarium culmorum* (*Fc*) cause crown rot in bread wheats in many countries including Australia and Turkey.

• Some studies have suggested that *Fc* colonisation may be restricted to lower parts of the stem and roots compared with *Fp*. While there have been studies conducted on the colonisation of each pathogen in mature plant stems, there has been no direct comparison between the two species.

• Including areas where the species overlap in their distribution, there is still little known about the interaction between the species when both are inoculated in the same plant.
Proposed areas of study

• Conduct seedling tests to investigate differences in colonisation between treatment groups *Fp* inoculated, *Fc* inoculated and co-inoculated in wheat seedlings.

• Assess the effect different temperatures have on colonisation for each treatment groups within seedlings.

• Assess seedling tissues above and below soil to determine if there is a difference in tissue locale colonisation. Tissues will be assessed by percentage of visual discolouration and amount of fungal mass by qPCR of each species.
  • Leaf sheaths, sub-crown internode and sections of primary roots will be evaluated

• Biomass of seedling roots and shoots will be compared between treatment groups to determine if co-inoculation poses an advantage in biomass reduction.
Proposed areas of study

• Assess the disease response to co-inoculation with Fp and Fc in 20 host genotypes featuring a range of susceptibilities in field trials.
  • Sources for genotype selection include data from the CAIGE website and unpublished data from QDAFF.

• Trial locations include sites in both Australia and Turkey.
  • Field trial locations include Wellcamp (Qld), Longerenong (Vic) and two sites in Turkey (Yozgat and Eskisehir).

• Visual assessment of wheat stem sections and qPCR of corresponding stem sections to evaluate both the amount of fungal DNA present and complement accuracy of visual assessment.
  • Two 6cm stem sections from the primary tiller of each plant will be assessed to determine colonisation up the stem of each treatment group.
  • Stem sections will be collected at post-milk development stage to avoid saprophytic growth caused by the fungi.
SIMILAR PROJECT FOR ROOT LESION NEMATODES
Identification of mechanisms of action of selected known and novel resistance genes in bread wheat, to the root-lesion nematodes *Pratylenchus thornei* and *Pratylenchus neglectus*

**PROJECT AIMS:**
- To identify in breeding lines and lines from genetic populations, individuals with unique combinations of resistance Quantitative Trait Loci (QTL) to *Pratylenchus thornei*
- Using association genetics and QTL screening approach, identify in CIMMYT germplasm, potentially novel QTL for resistance to *P neglectus* and *P thornei*
- To determine the effect and mechanism of resistance of individual QTL associated with resistance to *P neglectus* and *P thornei*, so that combinations of different resistance QTL can be recommended to breeders
Follow up with **SAGI** to improve trials design and data analysis. SBP program in touch with Dr Bev Gogel.

**249 Iranian landraces** selected based on drought resistant in Mexico will be screened for crown rot (Will be discussed with Lauren)

**From 11-24th July 2016 the 5th International Master Class in Soil Borne Pathogens will be run in Turkey with The Crawford Fund and partners.** Key Australian teaching experts including Dr Grant Holloway, Prof Stephan Neate & Ass Prof Ian Riley. Excellent opportunity to learn about Soil Borne Pathogens – expect approximately 24 participants.
“Understanding linear mixed models from the ground up: Statistical tools for the Turkish National Breeding Programs”
September 2-3, 2015 Eskisehir/Turkey
Thank You