



Coordinating global research for wheat

ANNEX 5

EXPERT WORKING GROUP MEETING AGENDA AND MINUTES

Meeting of the Expert Working Group on Durum Wheat Genomics and Breeding

Date: 30th May 2015

Location: Hotel FlyOn, Bologna (Italy)

Chaired by: Luigi Cattivelli (CRA Fiorenzuola) and Roberto Tuberosa (University of Bologna)

Participants

The list of participants is attached below

Apologies and Absentees

Karim Ammar (CIMMYT, Mexico)

Agenda

1. Welcome and update on the EWG activities
2. Valorisation and deployment of tetraploid wheat germplasm collections:
 - 2.1. Valorisation of germplasm collection at CNR (Italy) (Presenter: Gaetano Laghetti)
 - 2.2. Valorisation of germplasm collection in ISRAEL (Presenter: Tzion Fahima)
 - 2.3. Valorisation of germplasm collection at ICARDA (Presenter: Ayed Al-Abdallat for Ahmed Amri)
 - 2.4. Valorisation of germplasm collection at CIMMYT: Presenter (Tom Payne)
 - 2.5. Valorisation of germplasm collection at USDA-ARS: Presenter (Steven Xu)
 - 2.6. Valorisation of germplasm collection in Canada: Presenter (Curtis Pozniak)
 - 2.7. Exploitation of artificial induced variability Presenter (Jorge Dubcovsky)
3. Lunch
4. Group discussion on the following topics
 - 4.1. Priorities in molecular characterisation for durum wheat breeding
 - 4.2. Priorities in phenotypic characterisation for durum wheat breeding (including quality)
 - 4.3. Priorities for the introgression of new genetic variability in elite durum wheat breeding
 - 4.4. Opportunities from artificial induced variability
 - 4.5. How to enhance the collaboration on durum wheat genetic resources

5. Coffee break and poster vision
6. Presentation of the reports from the group coordinators and identification of the priorities for durum wheat germplasm exploitation
7. Final guidelines and next meeting of the EWG-DWGB

Attachments

MINUTES

1. Welcome and update on the EWG activities

The meeting was introduced by Roberto Tuberosa and Luigi Cattivelli.

Roberto summarised the recent activities/achievements of the EWG in terms of collaborative work: i) the publication of the first durum wheat consensus map based on the 90k chip from Illumina and 13 different mapping populations contributed by different members of the EWG (Maccaferri et al. 2014, *Plant Biotechnology Journal* 13:648-663), and ii) the publication of a special issue (Tuberosa and Pozniak 2014, *Molecular Breeding* 34:1527-1530) on durum wheat genomics where 12 manuscripts contributed by different EWG members have been published.

Luigi updated on an additional important achievement concerning the initiative for the sequencing of the durum wheat genome. In the last months a consortium of nine research groups (all members of the EWG) signed a Memorandum of Understanding to develop a collaborative activity towards the sequencing of the genome of the cultivar Senatore Cappelli (a historical Italian cultivar, founder of durum wheat breeding in Southern Europe).

2. Valorisation and deployment of tetraploid wheat germplasm collections

The EWG meeting included a full day workshop (30 May 2015) (including break-out discussion sections) to discuss germplasm resources and their exploitation to improve durum varieties. In the first part of the meeting five presentations described the main genetic resources available worldwide and how these resources are being implemented in terms of characterisation both at the genotypic and phenotypic levels.

The coordinators of the EWG selected five main examples of large tetraploid wheat collections at CNR (Italy, presenter: Betty Margiotta), in Israel (presenter: Tzion Fahima), at ICARDA (presenter: Ayed al Abdallat for Ahmed Amri), at CIMMYT (presenter: Tom Payne), at USDA-ARS (presenter: Steven Xu), and in Canada (presenter: Curtis Pozniak). Each speaker highlighted the main resources available and several examples of practical use of genetic resources for durum wheat improvement were given. Furthermore, an additional presentation dedicated to artificially induced variability (presented by Jorge Dubcovsky) highlighted the possibilities of using mutagenesis and TILLING by sequencing for the selection of new alleles capable of conferring new traits for cultivated plants (e.g., high resistant starch content). A discussion took place after each presentation and at the end of the session.

3. Group discussion and identification of the priorities for durum wheat germplasm exploitation

This part of the meeting aimed to identify international priorities to promote the exploitation of the tetraploid wheat genetic resources. Participants were divided into four groups and an intra-group discussion was organised on the following topics: i) Priorities in molecular characterisation for durum wheat breeding; ii) Priorities in phenotypic characterisation for durum wheat breeding (including quality); iii) Priorities for the introgression of new genetic variation in durum wheat breeding; iv) Opportunities from artificial induced variability; v) How to enhance the collaboration on durum wheat genetic resources.

At the end of the break-out sessions, a rapporteur from each group presented the results of the intra-group conclusions. A PPT file with the presentations of all rapporteurs is attached to this report.

Based on the priorities highlighted in each group the general discussion identified some key actions that should be implemented in the next months/years.

1. The participants agreed that active international cooperation in terms of both exchange of information and of genetic materials is essential to promote durum wheat breeding, particularly in countries with limited economic resources. In this respect, the EWG believes that a DURUM WHEAT REFERENCE COLLECTION could represent a useful platform to link the different breeding programs worldwide. This reference collection will ideally include several hundred genotypes representing a significant part of the existing variability in cultivated varieties and landraces across the globe. The collection will be genotyped and the genetic data as well as the seeds will be freely distributed for phenotyping. The EWG believes that a reference panel of germplasm wider than those already available at single groups, would help the durum wheat community by offering a common set of genetic material to work with and facilitating the exchange of genetic information in terms of markers, phenotypic data and haplotypes. For instance, once a valuable haplotype has been identified in an accession of the reference panel, the haplotype and the corresponding marker(s) will become available to all partners that have the reference material. ICARDA has already merged several collections from both elite lines and landraces (the T-CAP from USA, the IDuWUE from Bologna, 960 landraces by FIGS, novel varieties from Canada and Australia, and ICARDA) These collections could act as starting point of the Durum Wheat Reference Collection. The reference collection should assure representation of global diversity (also in terms of phenological adaptive traits) and statistical relevance for subsequent analysis.
2. Based on the available economic resources, the reference collection could be genotyped to different extents (from GbS to exome-resequencing) while phenotyping will be carried out by each partner according to his/her own interest. In the medium term, the reference panel could be complemented by additional resources for the introgression of new alleles in the cultivated germplasm.
3. The members of the EWG also underlined the need of a single durum wheat database with all genetics, genomics and phenotypic information. Having a unified database where such information will be held is a first step to make the resources accessible to anyone. The EWG recognises the need to work towards such a database as a global community.

In summary, the EWG believes that the assembly of a DURUM WHEAT REFERENCE COLLECTION and its implementation is a priority to enhance cooperation and breeding efficiency in durum wheat.

Addendum

At the end of the EWG-DWGB meeting, the outcomes were summarised and discussed during a **meeting of the Executive committee of the EWG**. The committee has agreed on the main

conclusions reported above and has discussed how to highlight the relevance of durum wheat (main crop in some regions) and how to implement the priority actions indicated during the EWG meeting.

Actions:

The coordinators of the EWG in collaborations with Filippo Bassi (ICARDA) will organise the reference panel on a voluntary basis, with input (as required) from the EWG members. The target is to agree on the accession list of the reference collection before the next sowing season (northern hemisphere).

By the end of 2015, a working plan for the implementation and exploitation of the Durum Wheat Reference Collection will be organised by the EWG executive committee.

A seed repository of the reference collection will be organised by ICARDA and the seeds will be made available as soon as possible (according to availability).

4. Final guidelines and next meeting of the EWG-DWGB

The next EWG meeting will be organised in San Diego at PAG in January 2016.

Additional documents

Group discussion with all presentation of the discussion leaders during the work for the identification of the priorities for durum wheat breeding (at the end of the document).

NAME		Organization	Country
Able	Jason A.	University of Adelaide	Australia
Abdallat	Ayed A	CIMMYT	Mexico
Araus	Jose L.	University of Barcelona	Spain
Bassi	Filippo	ICARDA	Morocco
Baum	Michael	ICARDA	Morocco
Blanco	Antonio	University of Bari	Italy
Bovina	Riccardo	University of Bologna	Italy
Bruschi	Martina	University of Bologna	Italy
Budak	Hikmet	SABANCI University	Turkey
Buerstmayr	Hermann	BOKU University	Austria
Cattivelli	Luigi	CRA-Fiorenzuola	Italy
Cerioti	Aldo	CNR Milano	Italy
Dubcovsky	Jorge	UC Davis	USA
Echenique	Viviana	CERZOS-CONICET	Argentina
Fahima	Tzion	University of Haifa	Israel
Fu	Bin Xiao	Canadian Grain Commission	Canada
Gadaleta	Agata	University of Bari	Italy
Gill	Kulvinder	Washington State University	USA
Giuliani	Silvia	University of Bologna	Italy
Margiotta	Elisabetta	CNR Bari	Italy
Maccaferri	Marco	University of Bologna	Italy
Mastrangelo	Anna Maria	CRA-Foggia	Italy
Milner	Sara Giulia	University of Bologna	Italy
Nigro	Domenica	University of Bari	Italy
Ormanbekova	Danara	University of Bologna	Italy
Papa	Roberto	University of Ancona	Italy
Payne	Tom	CIMMYT	Mexico
Pecchioni	Nicola	CRA-Foggia	Italy
Pozniak	Curtis	University of Saskatchewan	Canada
Priyanka	Gupta	University of Bologna	Italy
Reynold	Matthew	CIMMYT	Mexico
Royo	Conxita	IRTA	Spain
Salvi	Silvio	University of Bologna	Italy

Sciara	Giuseppe	University of Bologna	Italy
Sissons	Mike	University of New England	Australia
Solis Martel	Ignacio	University of Sevilla	Spain
Sonnante	Gabriella	CNR Bari	Italy
Tuberosa	Roberto	University of Bologna	Italy
Upuda	Sripada	ICARDA	Morocco
Valli	Fabio	University of Bologna	Italy
Xu	Steven	USDA	USA
Zamariola	Linda	University of Bologna	Italy

Total 42 participants

Group discussion on the priorities for germplasm exploitation for durum wheat improvement

EWG genomics and breeding of
durum wheat

Bologna 31 May 2015

Group 1

Challenges & Reality

BW – about 650-680 mmt

DW – about 30-35 mmt

5% of BW production on average globally

- Doesn't mean we should be defeatist
- There are some unique challenges that are important to durum
- While still being important to BW, there could be scope to build a case in durum for certain priorities

Priorities in molecular characterisation

What?

Lacking information on promoters,
introns, regulatory regions

Possible to work towards a CHIP being
designed?

Priorities in phenotypic characterisation

What?

- NUE, yield/protein dilution effect (global)
- Traits with low heritability but important quality attributes (e.g. mottling)
- Sensitivity to gluten intolerance (make durum less allergenic, potentially easier to start with durum and then move to BW)

Priorities for introgression of new genetic variation

What?

- Mining the diversity that's not in hexaploid by screening diverse sources of AB genomes
- Unique opportunity over BW in terms of resource exploration

Opportunities from artificial induced variability

What?

- E.g. TILLING populations (for understanding function – useful and unique over bread wheat)
 - Easier system, faster
 - Use durum as the model for commercial opportunities in bread wheat

How to enhance the collaboration on genetic resources

What?

- Overcome lack of access to international germplasm collections (free access, no strings attached)
 - Free up bottleneck of genetic variability that is available
 - Requires change in current practices
- Greater commonality across germplasm dbases
 - In a sense aim for a universal platform
 - Easy to say, extremely difficult to accomplish (recalcitrance)
 - Unique opportunity for durum to perhaps create a 'one-stop shop' for such germplasm collections

Group 2

1. Priorities in molecular characterization for durum wheat breeding

- Reduce de number of markers present en the 90 K chip to a small amount of markers useful for durum wheat
- Molecular markers for different genes for resistance to diseases (rust, fusarium)
- Molecular markers for traits related with adaptation to climate change
- molecular marker for quality traits

2. Phenotypic characterization

- Do we use platforms for phenotyping? (phenomics)
- For traits involve in adap´tation to drought, for example
- Roots, en relation with drought
- Quality: protein, grain weight, colour, gluten strength, cadmium

3. Priorities for introgression

- Resistance to septoria and fusarium
- Increase biomass
- Dwarfing genes giberelin sensitive

4. Opportunities for artificial induce variability

- Is a strategy more useful for gene discovery than for breeding. It is a problem for complex traits (quatitative traits)

5. How to enhance collaboration

- Look for interesting genes in landraces for the traits mentioned before, characterize them, identify molecular markers linked to them and initiate a prebreeding program to transfer these genes to a set of elite lines representatives of different regions (countries).

Group 3

Molecular Characterization of Durum Wheat

- Development of a “common panel” for molecular phenotyping
 - Collection of available SNP, transcriptomic, metabolic data
 - LD, haplotype structure, targeted resequencing (genetic variation/Pan Genome)
 - Genotyping platforms – do we need a specific tool for wheat? For breeding perhaps, but existing resources for hexaploid wheat are sufficiently dense for durum wheat
 - GbS as a strategy in durum – a consensus map of GbS and characterization of the “common panel”
- EWG to establish as a community a common panel

Priorities in Phenotypic characterization

- Focus on global vs. regional priorities
- Heat and drought stress (physiological characterization) in response to climate change
- NUE should be a priority (sustainability)
- Root phenotyping – Who is doing what? Is there really a need?
- Disease resistance in genetic resources – a focus on FHB and septoria
- Global Phenotyping platforms – what is available?
- Need a community effort to collect and distribute data that is already available

Priorities for Trait Introgression

- More diversity is it needed in durum wheat;
Do we collect and maintain? I.e Conservation (200-300 million per year)
Or do we utilize and develop tools ?
- General consensus to have the EWG work to support pre-breeding efforts
 - Dedicated efforts to develop tools and resources to allow effective utilization in breeding programs

Opportunities for Induced variation

- TILLING, Genome Editing, Transgeneic technology/ cis-genic possibilities
- Field testing of transgenic materials – Cario Egypt AGHAGIR;
- Move beyond functional genetic analysis to utilization
- We need genes for transfer and/or editing.....
- EWG could support opportunities to pilot support these technologies to assessing durum wheat

COLLABORATION

- Interconnection with other EWG of WI
- Support Sharing of information for
- Support Stronger interconnection of breeding programs

Group 4

Molecular characterization

- The characterization of the tetraploid wheats allow to access to a set of alleles not present in exaploid wheat (emmer, polonicum, turanicum, carthlicum, etc)
- For specific regions (e.g central asia, caucasian region) where tetraploid wild relatives have evolved there might be a lack of representation in the germplasm banks (organize new collections?).
- We suggest that the molecular characterization of a set of landraces/wild accessions (e.g. 1000) with exome capture resequencing approach (same technology used for TILLING population) **could be set as a priority for Wheat Initiative.**
- The accessions could be selected based on FIGS analysis and, if available a set of markers.

Phenotyping characterization

- The same collection used for exome capture should be phenotyped in multilocation trials in field and controlled conditions (different traits) with a care for the standardization of phenotyping work and for the monitoring of the environments (temperature, disease pressure, ...)
- Problems to be addressed: biorepository, databases, data sharing
- **Aims: develop a legacy for tetraploid wheat allele mining publically available.**
- **Expectation: discovery a new and large set of alleles (different from the ones present in hexaploid wheat).**

Tools for exploiting wild germplasm in durum wheat breeding

- There is a need to develop fundamental tools to promote the exploitation of wild germplasm in durum wheat breeding. We suggest the development of 3 main tools of world wide interest:
- **Open pollinated populations** where hundreds to thousands of accessions of durum, emmer, polonicum, carthlicum, turgidum, etc (including male sterility lines) are free to cross. A resource is already available from INRA and can be further exploited. // Other populations can be developed.
- **Large NAM populations** of with hundreds of accessions (selected based on different traits) crossed with a modern highly adapted cultivars.
- Develop a large set of **introgression line populations**.