



Coordinating global research for wheat

## Durum Wheat Genomics and Breeding EWG

### Annual report and action plan

NAME OF EXPERT WORKING GROUP
<b>DURUM WHEAT GENOMICS AND BREEDING</b>

LEADERSHIP & AUTHORSHIP	
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MEETINGS HELD (please attach minutes of these meetings using the template provided)						
Face-to-Face Meetings	Name	Date	Location	Duration	# EWG members present	Cost (€)
	EWG meeting	12 Jan 2015	San Diego (c/o PAG congress)	2 hrs	27	none
	EWG meeting dedicated to durum wheat germplasm resources	31 May 2015	Bologna	1 full day	42	14 358,03
Other Meetings	Type (online, etc)	Date	Location	Duration	# EWG members present	Cost (€)

AIMS OF THE EWG
<p>The EWG acts to reach the following aims:</p> <ul style="list-style-type: none"> <li>• Provide some synergy between durum wheat research groups.</li> <li>• Identify research priorities relevant to most groups in order to enhance opportunities for genetic progress in durum wheat breeding globally.</li> <li>• Promote the development of molecular tools/platforms open to the global durum wheat community via (i) a high-density SNP-based consensus map and (ii) a sequence of the durum genome and (iii) public reverse genetic tools (e.g. sequenced TILLING populations).</li> <li>• Promote the utilization of the durum wheat genetic resources through collaborative genotyping and phenotypic characterization of a reference collection including most of the main germplasm groups worldwide.</li> <li>• Enhance the capacity of breeders to access and use markers suitable for high-throughput marker-assisted selection.</li> <li>• Enhancing awareness and familiarity with genomics approaches applied to durum breeding through the organization of workshops and training courses.</li> <li>• Facilitate the formation of consortia aiming at raising funds for research projects nationally and/or internationally.</li> </ul>

2015 ACTIVITY REPORT
<p>Reminder of <b>EWG action plan for the duration of the EWG, with flow-chart indicating timeline and outputs</b></p> <p>The EWG seeks to generate synergy and added value to durum wheat research activities conducted by different groups worldwide by pooling the currently available resources and capacities under a single collaborative umbrella. A survey carried out in 2013 to identify the research priorities for durum wheat genomics and breeding was followed by two collaborative activities, the first one to develop a durum wheat consensus map (published in early 2015) and the second to sequence the durum wheat genome (presently in progress). In 2015, a workshop was organized where the EWG members discussed how to assemble a durum wheat reference germplasm collection (DWRC) that would become a reference panel for genotypic and phenotypic studies worldwide. <b>Overall, these activities will promote collaboration and enhance cohesion within the durum wheat community (most durum wheat scientist are members of the EWG) and the advancement in the use of genomics through a collaborative work based on collectively determined breeding priorities.</b> An updated flowchart illustrating the working plan of the EWG is presented below.</p>

2013	• Survey of research priorities
2014-15	• Durum wheat consensus map
2015	• Workshop on durum wheat genetic resources
2015-16	• Sequencing of durum wheat genome
2015-18	• Durum Wheat Reference Collection (DWRC)
<b>Objectives identified for 2015</b>	
In 2015 the EWG has focussed its activity on the coordination of an international network for the sequencing of the durum wheat genome and on the organization of a new, community-wide, effort for allele mining, exchange of useful traits, training of genomic models, and marker validation based on the establishment of the Durum Wheat Reference collection (DWRC).	
<b>Progress against aims in 2015</b>	
<p><b>Sequencing of the durum wheat genome.</b> In 2015, a number of groups have been involved in a community effort for the sequencing of the durum wheat genome. While the sequence of the old cultivar Cappelli is still in progress, sufficient resources have been collected and pooled to complete the work and a new sequencing strategy based on the 'DeNovo magic' software has been selected for the assembling of Illumina reads of the wheat cultivar Svevo. The contract with the software company (NRGene) to run the genome assembly is under negotiation. The same strategy has been recently used for the sequencing of wild emmer, <i>T. tauschii</i> and bread wheat. Once the durum sequence is available, a direct comparison of the genomes of wild and durum wheat will be possible. Sequencing work is now in progress and the first sequence draft should be available in the first semester of 2016. The sequencing work also supports the development of two new high-density durum wheat maps based on POPSEQ method that will be used to anchor the scaffolds generated after assembling onto a genetic map.</p> <p><b>Durum Wheat Reference collection (DWRC).</b> On May 31, 2015, the EWG members met in Bologna for a workshop dedicated to the discussion of the priorities and strategies to optimize the utilization of the durum wheat genetic resources. As main output of the meeting, the EWG decided to assemble the DWRC. This reference collection will include cultivars, elite lines, advanced breeding lines, landraces, and primitive tetraploids that best represent the genetic diversity currently exploited by durum wheat breeders and geneticists globally. The final DWRC panel will be extensively genotyped, the seed and data freely shared with the durum and bread wheat community, and competitive grants proposed for conducting extensive phenotyping, in addition to the exchange of those traits/alleles already identified by different groups. The DWRC should in time become the main global durum panel to be used by the whole community in all activities, across the next decade. It aims at becoming the 'one-stop' durum wheat platform for enhancing cooperation and breeding progress. It will facilitate the exchange of genetic information in terms of markers, phenotypic data (traits) and alleles. Following the workshop, a detailed action plan has been prepared and approved by the EWG members. In September 2015, a call for germplasm contribution to build the DWRC has been launched at the EWG level and more than 2,000 durum wheat accessions have been collected and assembled by Dr. Filippo Bassi, durum breeder at the International Center for Agricultural Research in Dry Areas or ICARDA. In November, all the accessions have been sown at the ICARDA research station in Terbol-Lebanon. In early 2016, the whole collection will be genotyped with a core set of markers and this information together with available passport and genealogy information will be used to select approximately 600 accessions that will constitute the final DWRC. The characterization of the tetraploid wheats of the DWRC will allow breeders to access alleles that may not yet have been exploited in their respective breeding programs.</p> <p><b>Release of the Kronos sequenced TILLING population.</b> The population developed by Jorge Dubcovsky includes 1,535 sequenced mutant lines and ~4,000,000 EMS sequenced mutations (~35 mutations per kb in the complete population). The TILLING resource was presented at the EWG meeting in Bologna and many EWG members are already using the resource. Currently, more than 100 researchers are using the database. Seeds of individual lines are distributed upon request.</p>	
<b>Outputs and deliverables in 2015</b>	
<p>All activities of the EWG aimed at enhancing the cohesion within the durum wheat community and promote collaborative genomics-based activities responding to collectively determined breeding priorities. The main achievements obtained in 2015 are detailed below.</p> <ul style="list-style-type: none"> <li>• A durum wheat consensus map has been assembled through a collaborative effort among a number of members of the EWG (Maccaferri et al. 2015, Plant Biotechnology Journal, 13: 648–663). This map provides the most accurate reference for mapping loci in durum wheat and allows for the best genetic bridge with the bread wheat consensus map in view of the fact the wheat 90K Illumina array was used in both species.</li> <li>• Sufficient funds have been collected worldwide to support the sequencing of the durum wheat genome, and the agreement with NRGene for assembly the durum wheat genome using the 'DeNovo magic' software is in progress.</li> <li>• During the meeting in Bologna the EWG has identified priorities for the access by all and exploitation by all of the available durum wheat genetic variability through the establishment of the DWRC.</li> <li>• A working plan for the implementation and exploitation of the DWRC has been discussed and approved by the EWG members.</li> <li>• More than 2,000 durum wheat accessions have been collected and they are currently under multiplication and evaluation for the assembly of the final DWRC panel.</li> </ul>	
<b>Contribution to Wheat Initiative objectives (<a href="http://www.wheatinitiative.org/about/objectives">http://www.wheatinitiative.org/about/objectives</a>)</b>	
<p>The EWG facilitates and coordinates research activities in genomics and breeding of durum wheat and, when possible, links some of the findings/materials in/of durum wheat to those of the bread wheat community. Additionally, the EWG aims at facilitating and offering additional opportunities for networking among the different stakeholders in order to advance knowledge/understanding of durum genomics and gene functions as well as to enhance the effectiveness of breeding programs. More in details, the EWG is contributing to the Wheat Initiative SRA with two specific activities:</p> <ol style="list-style-type: none"> <li>i) the sequencing of the durum wheat genome indicated as priority action in the SRA Subtopic 5.1 Enabling technologies and methods;</li> <li>ii) the exploitation of the tetraploid wheat genetic resources designed according to the priority actions indicated in the SRA</li> </ol>	

Subtopic 5.3 Genetic resources.
Links established with other Wheat Initiative activities
The EWG meeting in Bologna, dedicated to the exploitation of the genetic resources of tetraploid wheat, was attended by Ahmed Amri and Tom Payne, responsible for the organization of the EWG on Global Wheat Germplasm Conservation and Use Community. Their participation was intended to assure a coordination of the activities of the two EWGs.
Additional activities

ACTION PLAN FOR NEXT TWO YEARS						
Meeting planned for 2016						
<b>Face-to-Face Meetings</b>	Name	Date	Location	Duration	# EWG members expected	Estimated Cost (€)
	Durum Wheat Reference Collection Technical Meeting	Sept-Oct 2016	Rabat (Morocco) c/o ICARDA	2 days	About 30	25,000
	PAG	11 Jan 2016	San Diego (California)	Three hours	About 20	-
	EUCARPIA	2016	Zurich	Half day	About 15	-
<b>Other Meetings</b>	Type (online, etc)	Date	Location	Duration	# EWG members expected	Estimated Cost (€)
Priorities identified for 2016-2017						
During the next two years the following steps will be implemented:						
<ul style="list-style-type: none"> <li>Implementation of the DWRC step 1. <ul style="list-style-type: none"> <li>✓ Genotyping of the 2,000 durum accessions with a core set of approximately 100 KASpar markers, some of which representing or linked to important loci controlling phenology and disease resistance in durum wheat;</li> <li>✓ Generic preliminary phenotyping of the 2,000 durum accessions in the ICARDA nursery in Terbol (Lebanon).</li> </ul> </li> <li>Organization of an EWG- technical meeting. Michael Baum, director of the ICARDA Biodiversity and Integrated Gene Management Program and of the Morocco Platform has already agreed to host the meeting at the ICARDA headquarters in Rabat (Morocco). The meeting will be instrumental for the establishment and exploitation of the DWRC. The meeting will give the opportunity to discuss the preliminary genotypic and phenotypic data generated on the large germplasm collection (about 2,000 accessions) and will be focused to the selection of a core subset of accessions that will constitute the final DWRC panel. Furthermore the meeting will take decisions on: <ul style="list-style-type: none"> <li>✓ strategies for genotyping of the final panel with high-density marker (SNP) platforms</li> <li>✓ seed multiplication and distribution</li> <li>✓ specific phenotyping activities through the involvement of the EWG members.</li> </ul> </li> <li>Implementation of the DWRC step 2. <ul style="list-style-type: none"> <li>✓ after the definition of the final DWRC panel, a detailed phenotyping coordinated activity based on an international collaborative effort will be organized;</li> <li>✓ in parallel, a deep and cost-effective genotyping work will be carried out with the final DWRC panel.</li> <li>✓ development of a large RIL population from the cross Capelli x Langdon to bridge the genetic studies based on Cappelli derived germplasm (most EU material) with those based on Langdon derived germplasm (most US material). The RIL population is currently in F<sub>4</sub>.</li> </ul> </li> <li>Complete the sequence of the durum wheat genome through the existing international collaborations. This activity also includes the development of durum wheat POPSEQ maps that will also serve as new reference map for durum wheat.</li> </ul>						
Expected outputs and deliverables for 2016-2017						
Year 1 (2016) <ul style="list-style-type: none"> <li>• Durum wheat genome sequencing, assembly and annotation.</li> <li>• Implementation plan for the exploitation of the knowledge generated after the achievement of the sequence of the durum wheat genome (to be discussed at the meeting in Rabat).</li> </ul> Year 2 (2017) <ul style="list-style-type: none"> <li>• DWRC, the deliverable will include seed of all accessions, genotypic information and phenotypic data for a first set of traits.</li> <li>• Assembly of a high-density SNP-based consensus map.</li> <li>• Workshop on durum wheat at the Wheat Genetic Symposium (Tulln, Austria, 2017).</li> </ul>						
Timeline of activities for 2016-2017						
Year 1 (2016) <ul style="list-style-type: none"> <li>• Sequencing and assembling the durum wheat genome.</li> <li>• Assembling a new high-density SNP consensus map for durum wheat.</li> <li>• Genotyping and phenotyping activities for the definition of the DWRC.</li> </ul> Year 2 (2017) <ul style="list-style-type: none"> <li>• Advanced phenotyping activities for the DWRC.</li> <li>• Advanced genotyping for the DWRC germplasm.</li> </ul>						
<b>Additional documents</b>						

#### Meetings organised in 2014-2015

	2014		2015	
	Meeting 1	Meeting 2	Meeting 1	Meeting 2
Location	San Diego, USA	Obregon, Mexico	San Diego, USA	Bologna, Italy
Date/duration	16/01/2014	24/03/2014	12/01/2015	30/05/2015
# attendees	26	10	27	42
Cost of the meeting	238,43 €	- €	- €	14 358,03 €

#### Meetings planned in 2016

	Meeting 1	Meeting 2	Meeting 3
Location	San Diego	EUCARPIA Zurich	Rabat
Date/duration	Jan 2016	Aug-Sept 2016	Sept-Oct 2016