WGIN: Overview and update on RRRes WGIN research

Kim Hammond-Kosack
Rothamsted Research

9th WGIN Stakeholders Meeting 22th November 2011
The Defra Crop Genetic Improvement Networks
Announced July 2002

Dr Donal Murphy-Bokern
Arable Crop Sciences & Pesticide Safety Unit
Science Directorate
Defra
Overall Objectives

• Each Crop Genetic Improvement Network = Virtual Plant Breeding Institute

• To use crop breeding for the sustainable development of the arable sector

• To connect public sector science to the private sector

To recreate the best of the past
Networks established

- Wheat (WGIN)
- Oilseed rape (OREGIN)
- Short rotation coppice (BEGIN)
- Pulse crops
- Miscanthus
- Oats
The longer-term vision

• A strong crop breeding sector deploying the best technologies science can offer

• A strong strategic and applied research base competing effectively for resources

• A strong base for international partnerships

• More resource efficient and productive crops
The Defra WGIN

Grain Producers and Utilisers

9 UK WHEAT BREEDING COMPANIES

MODEL SPECIES

EU

BBSRC

OTHER CEREALS

INTERNATIONAL
The modest WGIN funds would attract additional funds to wheat research by other sponsors.
Projects of 5 years duration

The WGIN 1 project (2003 – 2008) - £1.80 million
The WGIN 2 project (2008 – 2013) - £1.95 million

WGIN 2 project – funded partners
John Innes Centre
University of Nottingham
Rothamsted Research
Improving the environmental footprint of farming through crop genetics and targeted traits analysis
Defra’s current policy priorities addressed by WGIN

1. Support and develop British farming and encourage sustainable food production
Defra’s current policy priorities addressed by WGIN

2. Help to enhance the environment and biodiversity to improve quality of life

Increase in England of Nitrate Vulnerable Zones (NVZ) due to arable activities 2002 (blue) to 2009 (pink)
Defra’s current policy priorities addressed by WGIN

3. Support a strong and sustainable green economy, resilient to climate change
Wheat Genetic Improvement Network (WGIN) 2008-2013

Tools and Resources

2. Near Isogenic lines (NILs) *

3. The Avalon x Cadenza Mapping pop^n

4. Paragon gamma and EMS pop^n

5. AE Watkins and Gediflux collections

6. New mapping pop^n for WUE (9) and 2 new pop^n to align WGIN 2 with the international wheat genome sequencing effort

Targeted traits

7. Insect resistance (RRes) *

8. Nitrogen use efficiency (NUE) Quality QTLs linked to NUE (RRes)

9. Drought tolerance (UoN) *

10. Take-all disease (RRes) *

11. Introgression of extreme Septoria resistance from T. monococcum into hexaploid wheat (RRes)

12. Interconnecting the three soil based traits (8,9,10)

Key control points (Blue)
cross connections (Red)

13. Grain archiving
Characterisation and provision of genetic resources

The AE Watkins spring and winter wheat collection (JIC)

1930s collection from markets in 32 countries

Seed now available for > 1000 ‘purified’ lines

Represents germplasm never used in UK wheat breeding programmes

Simon Griffiths / Simon Orford
Trait identification

1. Improved nitrogen use efficiency (NUE)

2. Grain quality (QTLs) linked to NUE

3. Improved water use efficiency (WUE)

Consecutive years of field trials
Drought Tolerance / Water use efficiency (WUE)

- Searching for scoreable traits
- Identifying genetic markers
- Creating a drought specific germplasm collection
- Developing a suitable mapping population cv Paragon x Garcia

John Foulkes
Trait identification – RRes

2. Reducing pest and disease pressure

Aphids  

Septoria leaf blotch  

Take-all fungus

Annually all crops at high risk

A major problem for 2nd / 3rd wheat crops

2nd wheat syndrome
Septoria resistance

Hexaploid wheat

Triticum monococcum - diploid wheat AA

No lesions !!!

Field assessment over 5 years

Fine mapped locus to Chr7A

Introgression breeding

Pairing locus mutant \( ph1 \)

cvs Chinese Spring, Paragon

Take-all resistance in \( T. \) monococcum

Infected roots

Three mapping populations produced and \( F_6 \) populations to be screened in 2012

Root with Take-all (%)

SED=3.718

Triticum monococcum accessions

Hereward A B C D E F G H I J K

Taking advantage of the natural resistance in diploid wheat in combination with diploid introgression breeding.
Take-all disease – soil-borne fungus

In 1\textsuperscript{st} wheats - no disease problem

A major problem for 2\textsuperscript{nd} / 3\textsuperscript{rd} wheat crops

\textbf{2\textsuperscript{nd} wheat syndrome}

The risk of Take-all is largely dependent on the amount of inoculum in the soil at the time of sowing

Typical take-all patch showing stunting and premature ripening of the crop
An important WGIN 1 discovery

The genotype of the 1\textsuperscript{st} wheat influence the amount of take-all inoculum build-up in the bulk soil

Evidence that wheat cultivars differ in their ability to build up inoculum of the take-all fungus, \textit{Gaeumannomyces graminis} var. \textit{tritici}, under a first wheat crop

V. E. McMillan, K. E. Hammond-Kosack and R. J. Gutteridge*  

Department of Plant Pathology and Microbiology, Rothamsted Research, Harpenden, Hertfordshire AL5 2JQ, UK

This study used the 1\textsuperscript{st} wheat NUE diversity trial

Richard Gutteridge
WGIN 2 Interconnecting the three soil based traits

**Aim:** To identify the lines with good tolerance to multiple stresses (*years 4 – 5*)

What are the similarities / differences between the three traits?
Accessing the WGIN germplasm

Two routes:
RRes – by E. mailing directly to WGIN JIC - Genetic Resources Unit

Accession numbers over 40,000 for RRes WGIN accessions

Mike Ambrose
Central storage of grain from the field trials

8 years of field trials

The stored samples - 500 g / 1 kg grain at -20 C

~ 6,000 samples with associated metadata

Key biological resources for new projects and / or pilot studies
The Networking objectives

8 of the 20 activities
The Defra WGIN: Dissemination, Liaison and Communication

Annual “Stakeholders’ Forum” (Nov)
Focussed Workshop – 2009 ‘A x C mapping pop’n’
2010 – DArT marker analysis

Workshops with overseas partner organisations:
   CIMMYT, INRA, 2010 – Serbia / Eastern Europe
   2011- Brazil

Web Site (www.WGIN.org.UK )
Six Monthly Electronic Newsletter
Scientific publications
Annual displays at ‘Cereals’
E. mail:wgin.defra@bbsrc.ac.uk
Welcome to WGIN 2nd Phase (2009-2013)

Defra Wheat Genetic Improvement Network - Improving the environmental footprint of farming through crop genetics and targeted traits analysis

Background

The UK government is committed to more sustainable agriculture but this vision is facing an ever expanding range of environmental, energy and climate change challenges. Wheat is grown on a larger area and is more valuable than any other arable crop in the UK. Established in 2003, the Wheat Genetic Improvement Network (WGIN) arose directly from a realisation in the early 2000s that over the preceding two decades there had been a widening disconnection between commercial plant breeding activities and publicly-funded plant and crop research. The overall aim of WGIN is to generate pre-breeding material carrying novel traits for the UK breeding companies and to deliver accessible technologies, thereby ensuring the means are available to produce new improved varieties. An integrated scientific core which combines underpinning work on molecular markers, genetic and genomic research, together with novel trait identification, are being pursued to achieve this goal.

Recent Updates

OLD Site - The old site is still available here.

Disclaimer: WGIN is a publicly funded project and the data and resources it generates are freely available to the research community, providing that the use of any WGIN data and resources are acknowledged.
Economic impact of WGIN

Special focus Newsletter May 2008
- £4.3 M new grants + £2.95 M existing grants
The cost of WGIN 1 was £1.8 M over 5 years

Another WGIN project impact audit just completed
- 20 new projects described in Nov 2011 Newsletter
  - £15.39 M new grants
14 projects partially industry funded

BBSRC, HGCA, Defra, Technology Strategy Board, Scottish Government, EU Lawes Trust, Rothamsted International, John Oldacre Foundation

The cost of WGIN 2 is £1.95 M over 5 years
WGIN in the wider context

**DRIVERS**
- Defra policy
- breeders’ requirements
- ability to deliver
- academic insight

**GENETIC VARIATION IN TRAITS**

**SOURCES**
- natural
- induced
- transgenic

**WGIN**
- breeding tools
  - IP free

**SELECTION**

**PLANT BREEDING**

**IMPROVED VARIETIES**

**CONSUMER BENEFITS**
- healthy
- safe
- affordable

**ENVIRONMENTAL /POLICY BENEFITS**
- improved N economy
- reduced agrochemical/fungicide use
- biofuels
- climate change
- improved water quality

**ECONOMIC BENEFITS**
- food security
- reduced imports
- improved processing quality
### WGIN (present)

- **RRes** - Peter Shewry, Kim Hammond-Kosack, Malcolm Hawkesford, Richard Gutteridge, Kostya Kanyuka, Suzanne Thrussell
- **JIC** - Simon Griffiths, Susan Freeman, Cathy Mumford
- **UoN** - John Foulkes, Jayalath DeSilva

### WGIN (past)

- **RRes** - Andy Phillips, Katie Tearall, Peter Barraclough, Hai-Chun Jing, Carlos Bayon, Sam Irving
- **JIC** - John Snape, Robert Koebner, Liz Sayers, Christian Rogers, Pauline Stephenson, Leodie Alibert
- **Lesley Smart**
- **Ruth Gordon-Weeks**
- **Elke Anzinger**
- **Simon Orford**
- **Michelle Leverington**

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**The farm / trials staff at all the sites used**

The Plant Breeders

The Management team

[www.WGIN.org.UK](http://www.WGIN.org.UK)
The WGIN disclaimer

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In grant applications as well as final publications

We developed in early 2010: A generic statement on data and resource use by others

Please use this statement and inform us of all successful activities
Three Defra’s current policy priorities addressed by WGIN

1. Support and develop British farming and encourage sustainable food production

   Help to enhance the competitiveness and resilience of the whole food chain, including farms and the fish industry, to help ensure a secure, environmentally sustainable and healthy supply of food with improved standards of animal welfare
Three Defra’s current policy priorities addressed by WGIN

2. Help to enhance the environment and biodiversity to improve quality of life

Enhance and protect the natural environment, including biodiversity and the marine environment, by reducing pollution, mitigating greenhouse gas emissions, and preventing habitat loss and degradation.

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Three Defra’s current policy priorities addressed by WGIN

3. Support a strong and sustainable green economy, resilient to climate change

Help to create the conditions in which businesses can innovate, invest and grow; encourage businesses, people and communities to manage and use natural resources sustainably and to reduce waste; work to ensure that the UK economy is resilient to climate change; and enhance rural communities