Overview of the WGIN4 Core Project

March 2018 – March 2023

Wheat Genetic Improvement Network

Kim Hammond-Kosack

Rothamsted Research

Department for Environment Food & Rural Affairs

30th March 2022, 19th Stakeholder meeting, RRes, Herts

Wheat Genetic Improvement Network

Department for Environment Food & Rural Affairs

WGIN provides a research platform for the delivery of

- **tools**
- **resources**
- **bioinformatics (large scale DNA analyses)**

- **expertise for the identification of naturally occurring (useful) genetic variation in new traits**

Yield and quality per se are excluded





The Defra WGIN

started in 2003

Grain Producers and Utilisers

9 UK WHEAT BREEDING COMPANIES

MODEL SPECIES

OTHER CEREALS

WGIN

EU

INTERNATIONAL

BBSRC

The WGIN funds would attract additional funds to wheat research by other sponsors

Mission statement - WGIN 2015 to 2023

Improving the resilience of the wheat crop through genetics and targeted traits analysis

WGIN4 Core Research Project split

70 % trait analyses

30% development of new genetic and genomic resources

Four overarching challenges:

20% Enhanced Resource Efficiency Nitrogen (NUE)

25% Sustainability - Yield Stability Spring drought, lodging* and stem anchorage*

30% Resilience Resistance to slugs*, BYDV* vectored by aphids, Septoria, Yellow rust and the take-all root pathogen

25% Quality Yield, grain protein, grain specific weight*, NUE and nutrient partitioning as affected by N-input and disease*

*** New for WGIN4**

New resources / tools developed in WGIN
THE BIG FIVE

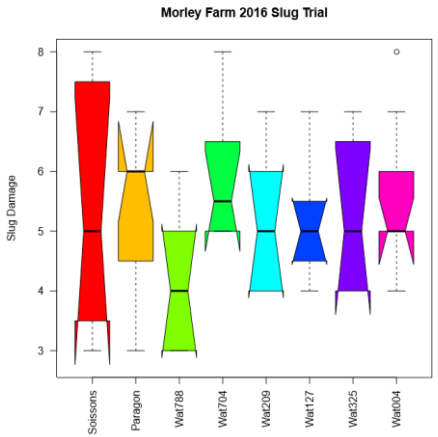
- **A reference UK mapping population**
  Avalon x Cadenza (DH pop^{n}, 203 lines + 584 lines)
  The world's most phenotyped mapping population
- **Restoration of the AE Watkins wheat collection**
  > 1300 landraces from 32 countries
  never previously used in modern breeding
- **EMS mutagenised TILLING populations**
  Cadenza and Paragon (> 5000 lines + 1200C lines DNA)
- **A global collection of *T. monococcum* accessions (AA genome) ~ 323 lines, 34K breeders array + 5 F_6 pop^{n}**
- **Grain samples (-20C) from WGIN cultivar diversity trials since 2003 (3 or 4 N treatments / all plots)**

Watkins lines with high levels of resistance to pest and pathogens

Slugs

1st screened in lab tests

Best lines field trialled



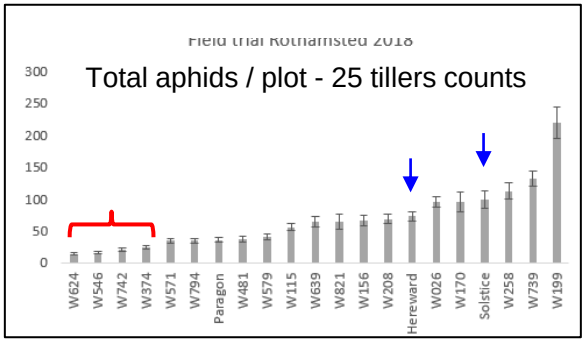
Watkin 788

John Innes Centre

Aphids

1st screened in lab tests

Best lines field trialled

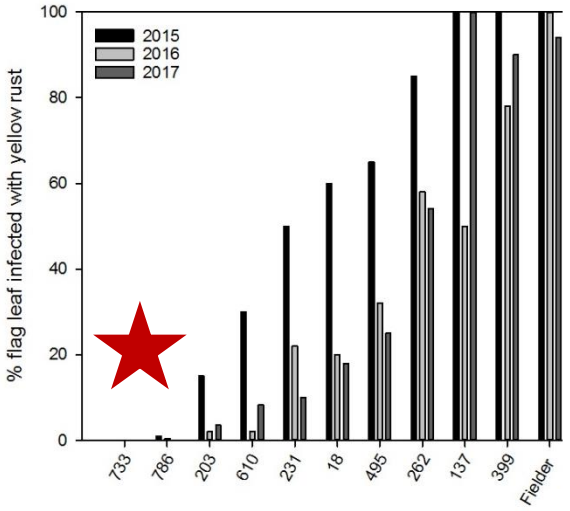


Watkins 374, 546, 624, 742

ROTHAMSTED RESEARCH

Yellow rust

Field trials since 2007



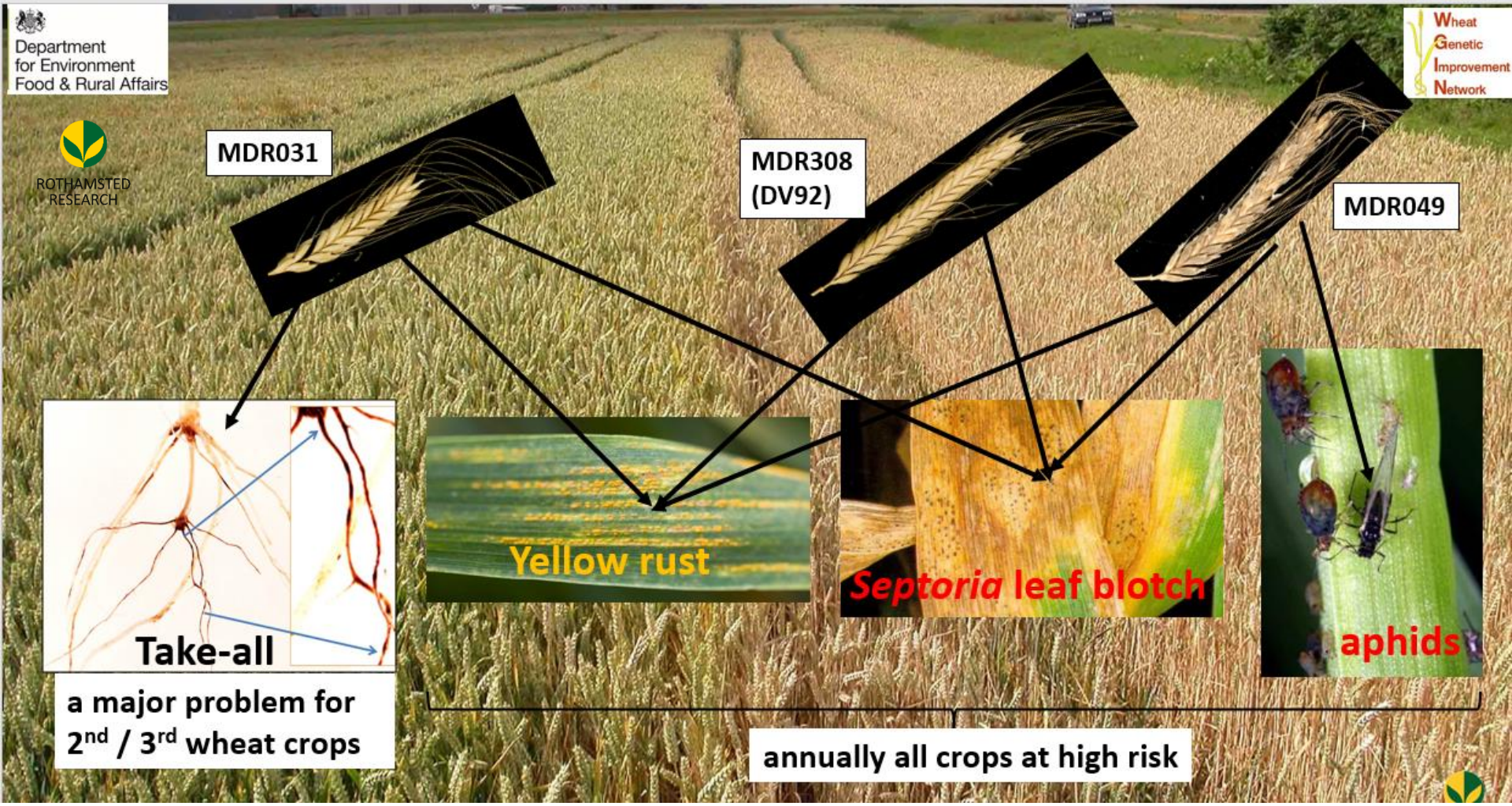
Watkins 733, 786

ROTHAMSTED RESEARCH

Remained resistant throughout all the Yr race changes

Triticum monococcum (diploid, AA genome) a good source of resistance to various pathogens and pests

rarely been used in modern wheat breeding



Introgression breeding via Durum wheat – BC2 or BC3 Paragon, then 3 rounds of single seed descent (SSD) > 99% Homozygosity ~ 1,000 lines

WGIN Diversity Trial

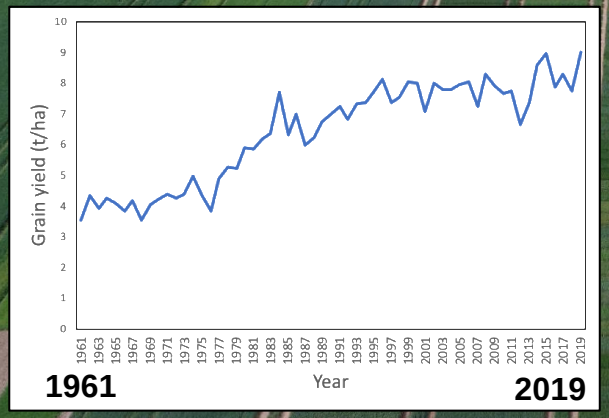
Resource Use Efficiency + Quality linked to NUE + Yield Stability + Resilience

Malcolm Hawkesford and Andrew Riche

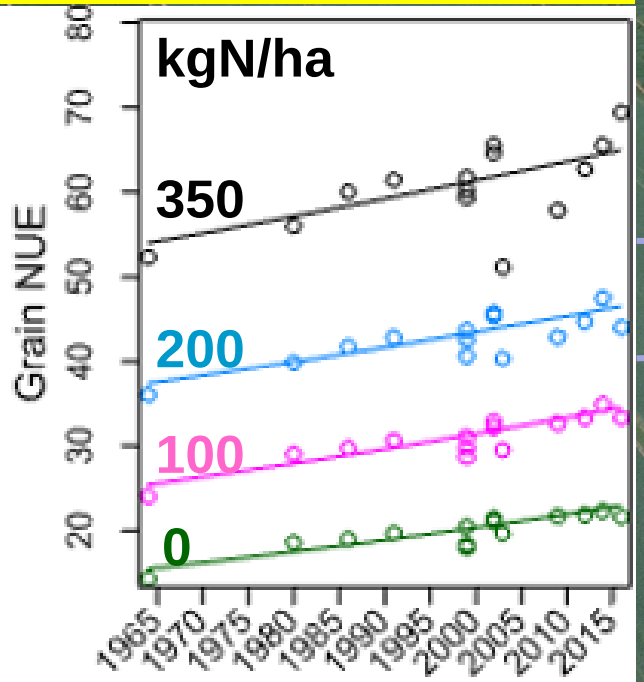
WGIN Diversity Trial

Resource Use Efficiency + Quality linked to NUE + Yield Stability + Resilience

UK farm gate wheat yields have stagnated



Increases in NUE seen in WGIN trial based on year of release of variety



Malcolm Hawkesford and Andrew Riche

19th Consecutive Diversity Trial 2021-2022

- 20 varieties, 3 levels of N (100, 200, 350 kg/ha)

- Two fungicide regimes – standard practice and reduced - some disease build up / earlier canopy senescence - 4 years
- No insecticide regime

- Soil N samples collected, grain and straw samples taken at harvest for multiple analyses

- Weekly UAV flights
- VNIR 270 bands, SWIR 273 bands
- LiDAR Point Cloud – 184 Million points – new 3D hyperspectral measurements

Septoria leaf blotch

Yellow rust

Bird-cherry oat aphid (*Rhopalosiphum padi*)

English grain aphid (*Sitobion avenae*)

Focus : NUE and nutrient partitioning as affected by N-input and disease

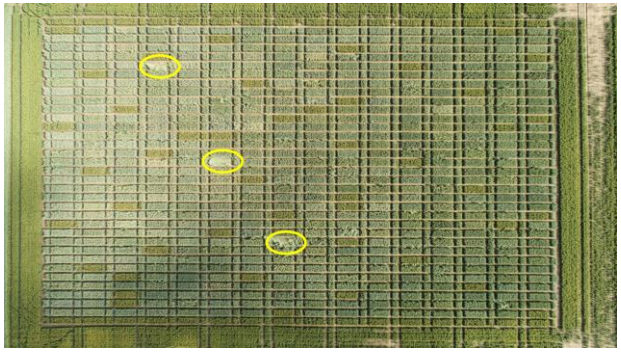
Dissecting Lodging in Paragon x Joss Cambier

Lodging – major cause of yield loss and affects quality characteristics

Joss Cambier - UK winter wheat

RIL population selected as JC similar to Paragon

Phenotyping of RILs: DTEM, plot strength, lodging (assessed from drone imaging), height (HT), ear count, stem strength (= plot strength / ear count), ear and stem weight, SW, YLD, TGWT, wall and stem thickness



Clare Lister and Simon Griffiths

Dissecting Lodging in Paragon x Joss Cambier, and beyond…

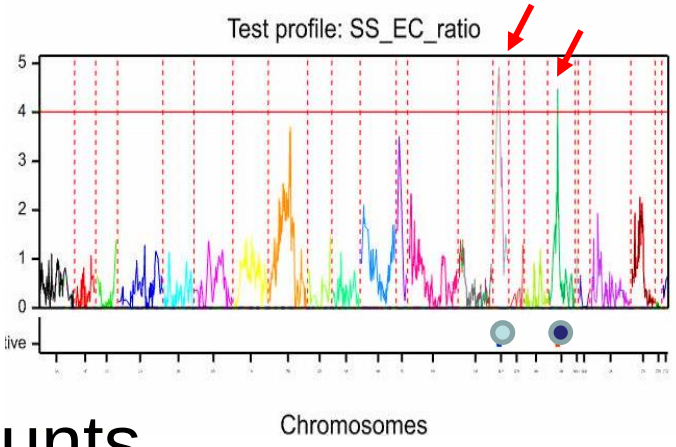
Lodged plants

flower slightly later

are significantly taller

have weaker stems

have significantly higher ear counts



Some phenotypic traits map to QTLs from JC or Par

i.e. **Stem Strength**

Lodging Trial 2021-2022	**How much does plot strength, stem strength, and anchorage data predict standing power** **Is high stem strength + high anchorage best combination?**

Wide variety of lines in Lodging trial

Selected strong + weak Elite wheats, RothRes Diversity Panel,

Selected EMS dwarfs, Parental lines,

Selected Par x Garcia / Par x Joss Cambier / Par x Watkins 110

The Networking objectives

Maintaining and enhancing the public – private network

9 activities

The Defra WGIN: Dissemination, Liaison and Communication

Annual “Stakeholders’ Forum” (Nov) 70-110 attendees

Focussed Workshop – 2009, 2013 ‘A x C mapping pop^{n}’

2010 – DArT marker analysis, **2022 – Yield Stability**

Workshops with overseas partner organisations:

Seven funded by BBSRC (2018 – Kazakhstan, 2023? - Baltic)

Web Site (www.WGIN.org.UK), Electronic Newsletters

Scientific publications ~ 93 articles

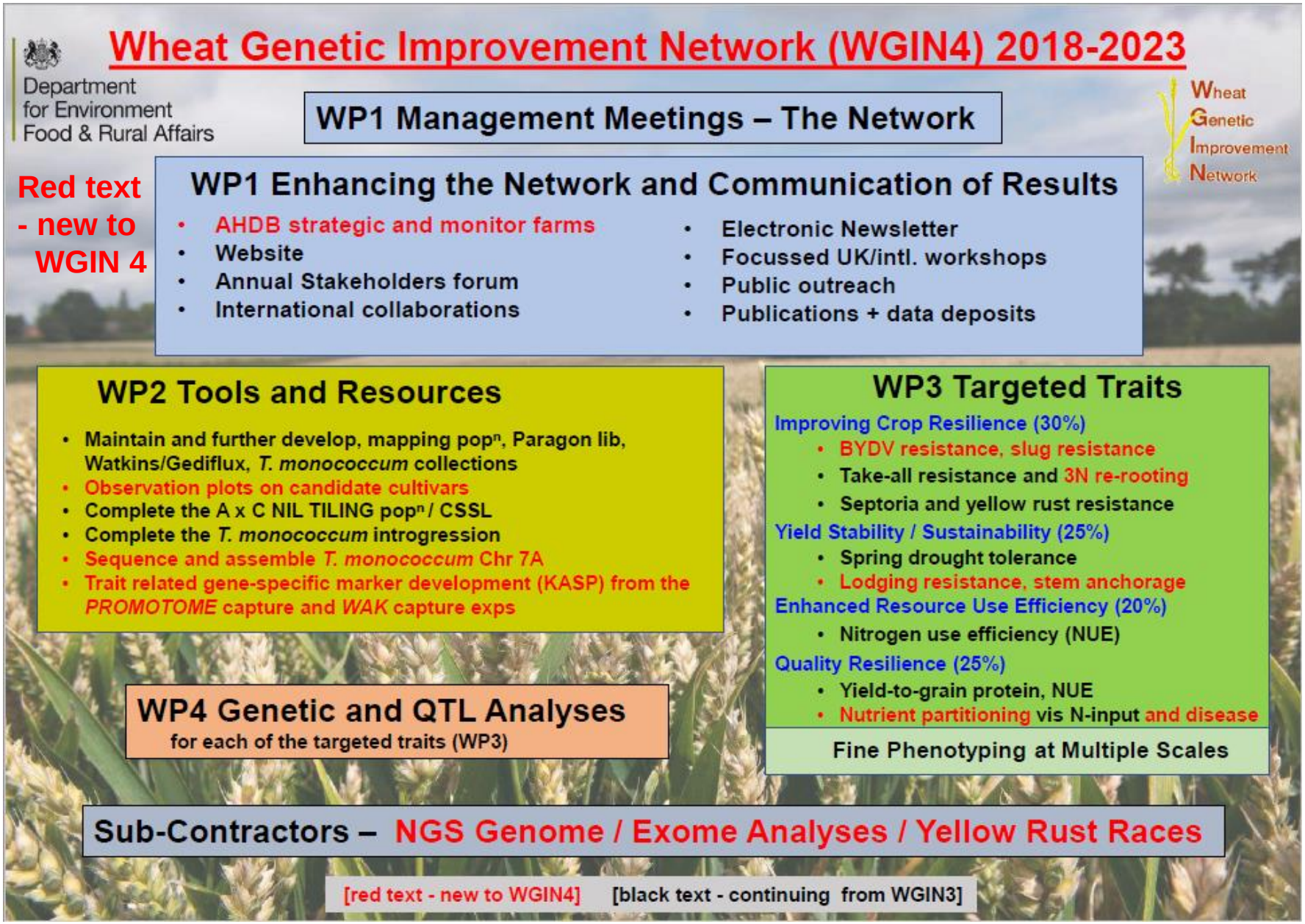
Annual displays at ‘Cereals’

E. mail: wgin.defra@bbsrc.ac.uk

Twitter Handle - **@WheatGIN**

Wheat Genetic Improvement Network

Read more about WGIN4 go to the April 2019 Newsletter



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Defra

www.WGIN.org.UK

Helen Riordan, Andy Cuthbertson, *Martin Cannell,
Giulia Cuccato and David Cooper (RAG)

WGIN3 / WGIN4

RRes - Kim Hammond-Kosack
Peter Shewry
Malcolm Hawkesford
Andrew Riche
Javier Palma-Guerrero
Gail Canning
Lawrence Bramham
Michael Hammond-Kosack

JIC – Simon Griffiths
Clare Lister
GRU – WGIN seed stocks

Sub-contractors

Bristol Genomics – Jane Coghill's team
Arbor BioSciences, Michigan, USA
NIAB, Cambridge*

*new WGIN 4

The Management team

The Plant Breeders (9)
ADAS
AHDB
NIAB
Univ Bristol
Defra

Former RRes colleagues

Vanessa McMillan
Gia Aradottir
Kostya Kanyuka

Affymetrix (35K wheat breeders array)

Department for Environment Food & Rural Affairs

The farm / trials staff at all the sites used
Numerous summer students