

Overview of the WGIN4 Core Project

March 2018 – March 2023



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Rothamsted Research



Department
for Environment
Food & Rural Affairs

3rd March 2021, 18th Stakeholder meeting, RRes, Herts

- 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

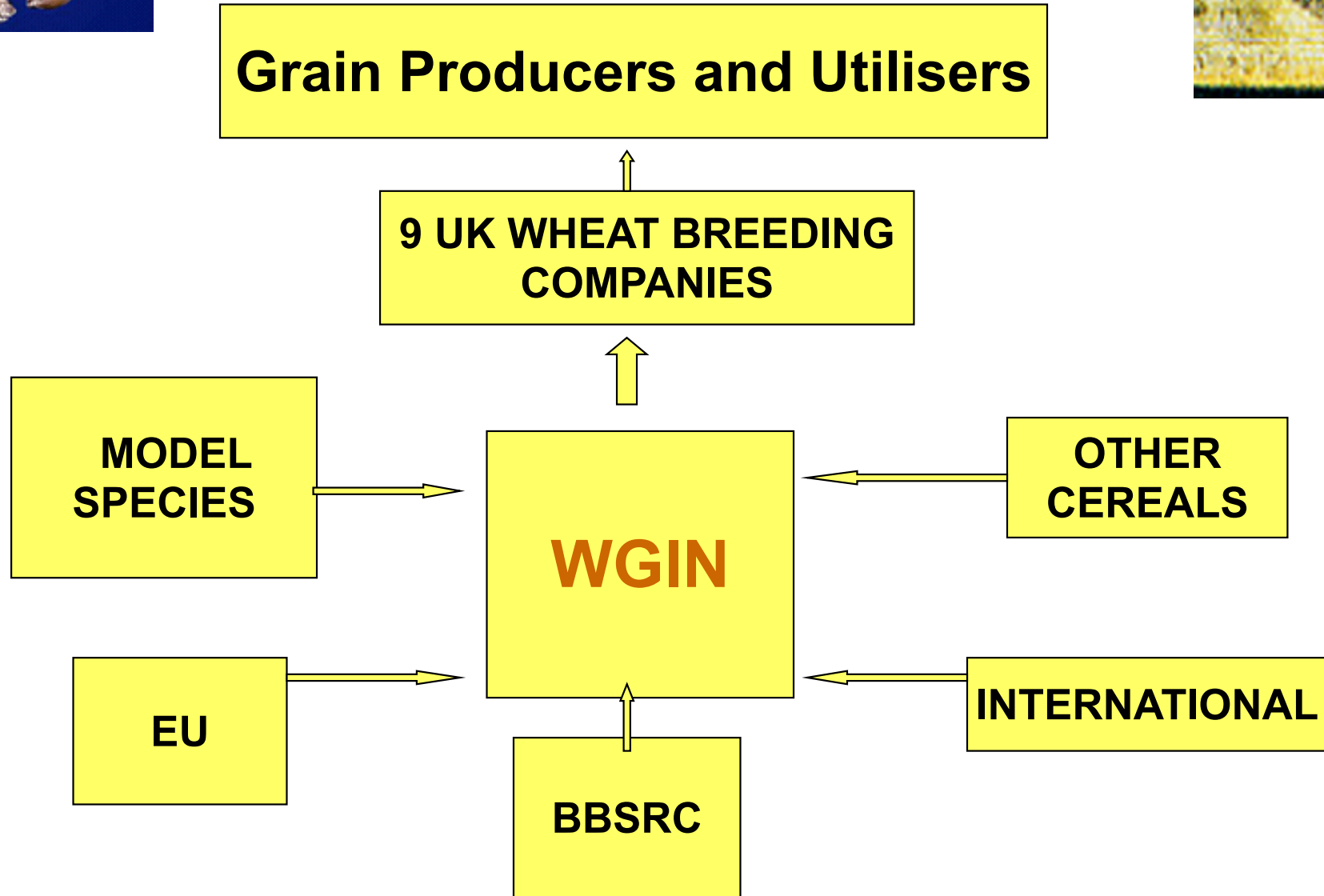
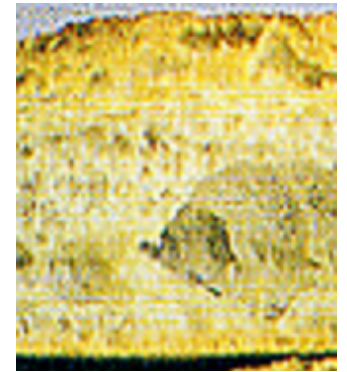
Yield and quality per se are excluded





The Defra WGIN

started in 2003



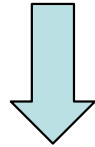
The WGIN funds would attract additional funds to wheat research by other sponsors

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 popⁿ, 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 F₆ popⁿ
- **Grain samples (-20C) from WGIN cultivar diversity trials** since 2003 (3 or 4 N treatments / all plots)

Trait identification - RRes

2. Reducing pest and disease pressure

Aphids



***Septoria* leaf blotch**



Yellow rust



annually all crops at high risk

The restored AE Watkins wheat collection

**~1300 landraces from 32 countries collected in 1930s
never previously used in modern breeding**

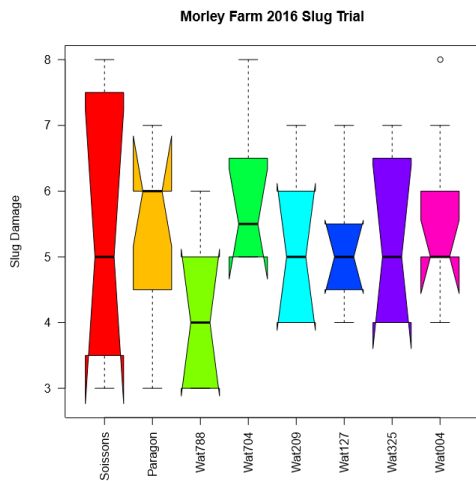
Screened for multiple traits over multiple seasons



Watkins lines with high levels of resistance to pest and pathogens

Slugs

1st screened in lab tests
Best lines field trialled

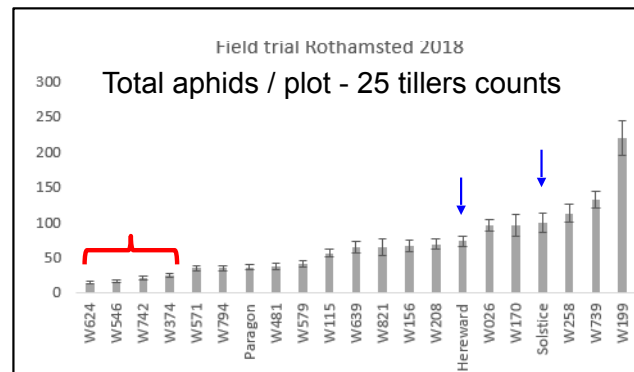


Watkin 788



Aphids

1st screened in lab tests
Best lines field trialled

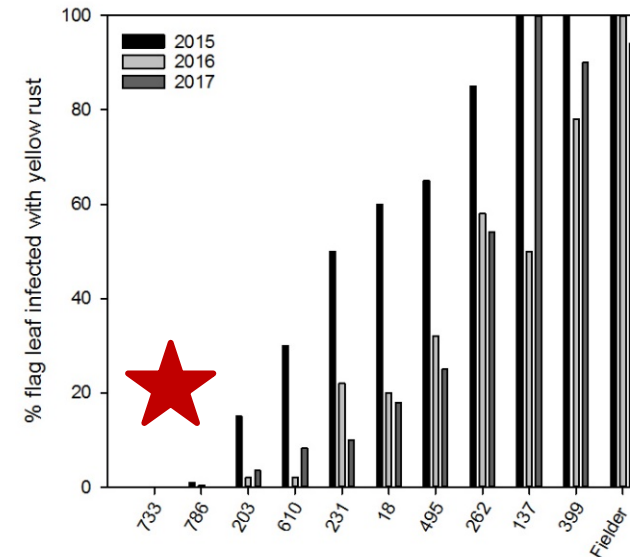


**Watkins 374, 546,
624, 742**



Yellow rust

Field trials since 2007



Watkins 733, 786



ROTHAMSTED
RESEARCH

**Remained resistant
throughout all the
Yr race changes**

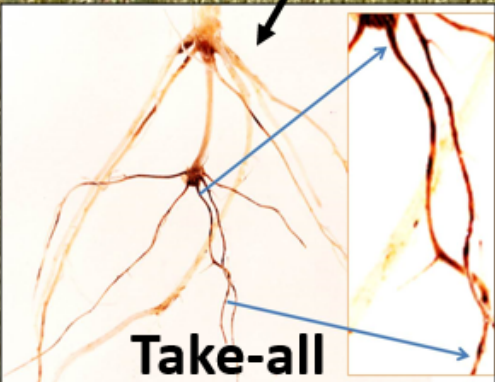
Triticum monococcum (diploid, AA genome) a good source of resistance to various pathogens and pests rarely been used in modern wheat breeding

Department for Environment Food & Rural Affairs



ROTHAMSTED RESEARCH

Wheat Genetic Improvement Network



Take-all

a major problem for 2nd / 3rd wheat crops



Yellow rust



Septoria leaf blotch

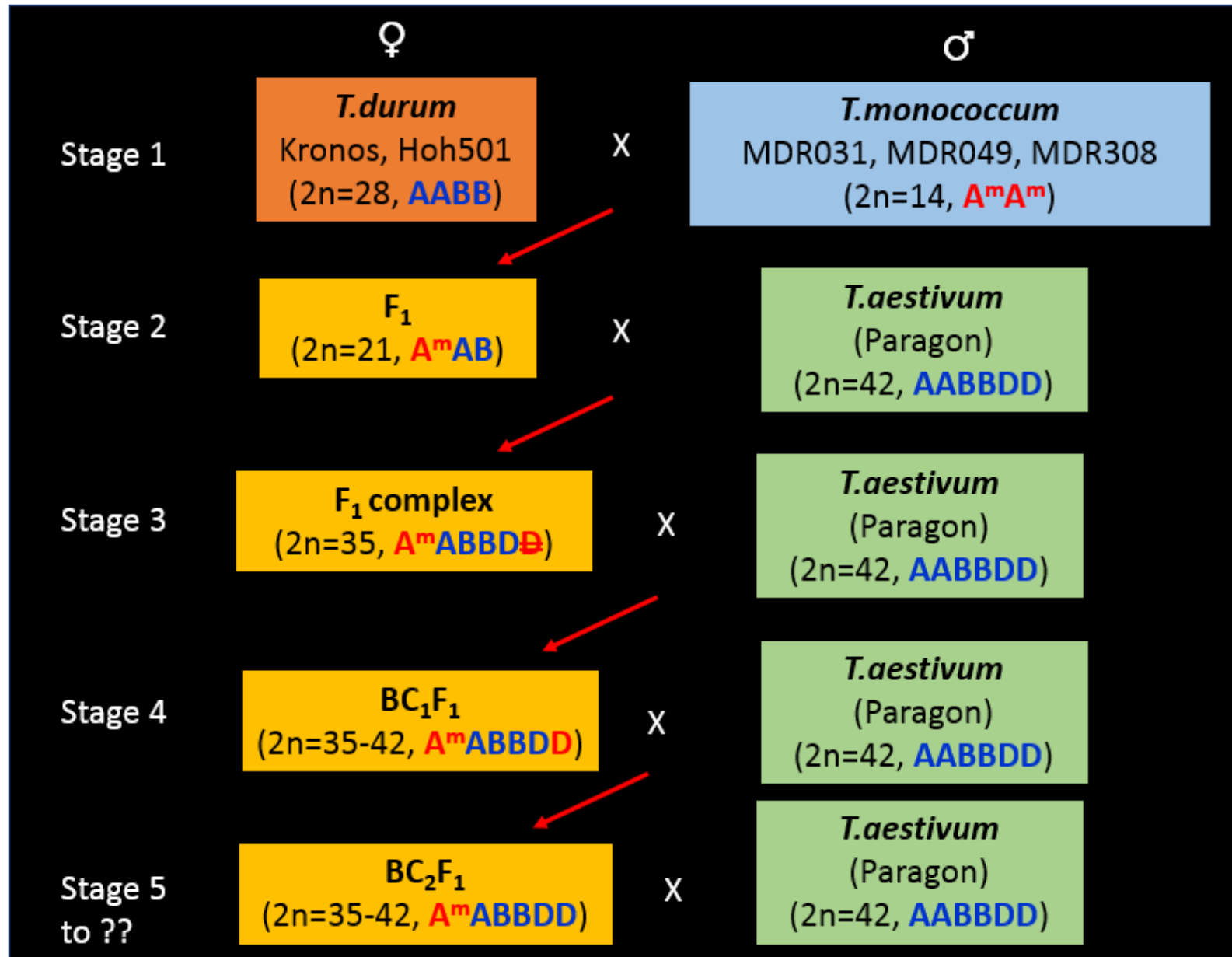


aphids

annually all crops at high risk

ROTHAMSTED RESEARCH

T. monococcum introgression : Using Tetraploid *T. durum* as a Bridging Species

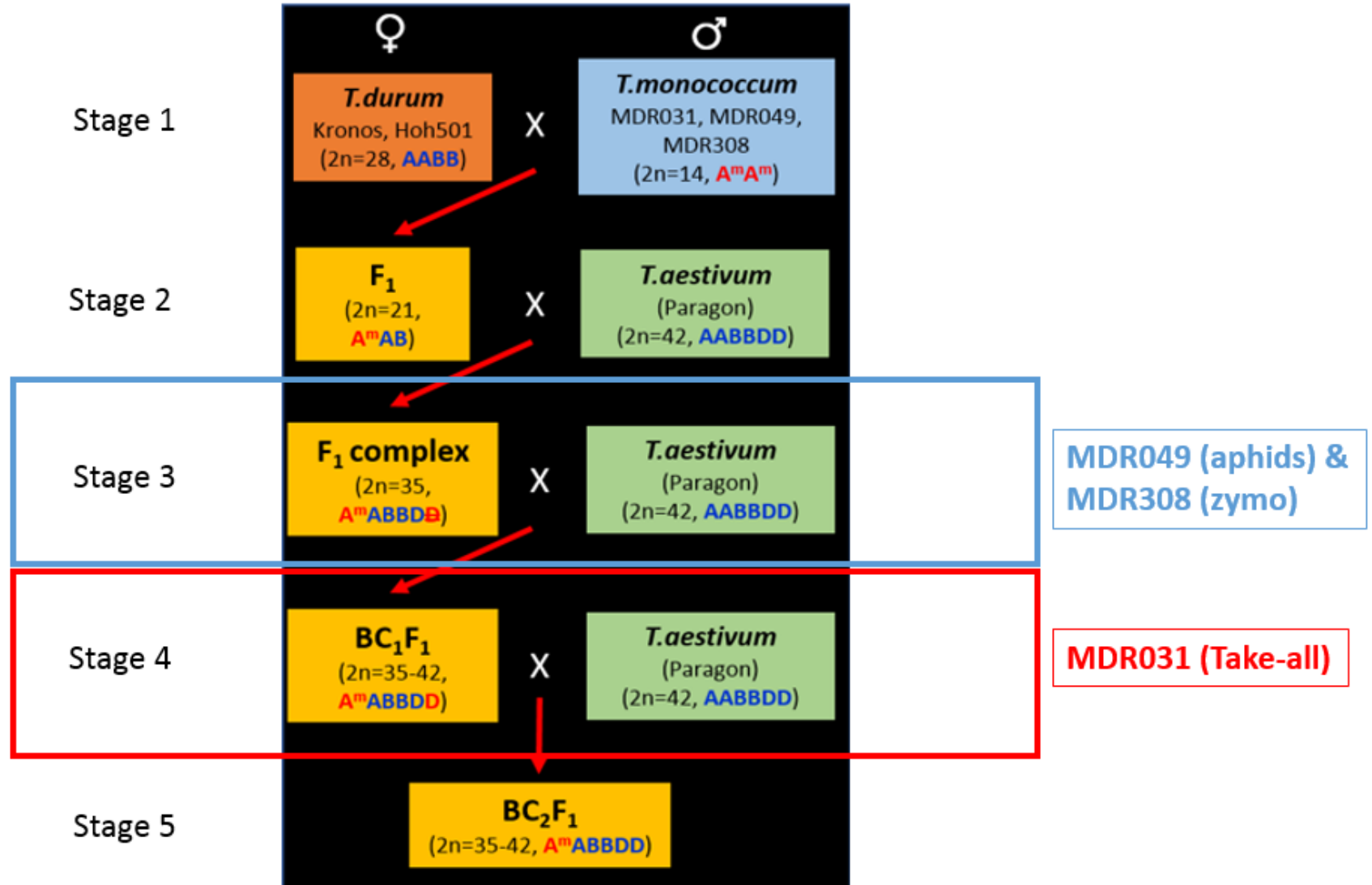
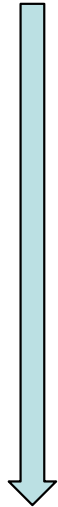


T. monococcum introgression - progress so far

increased
fertility

~0.5%

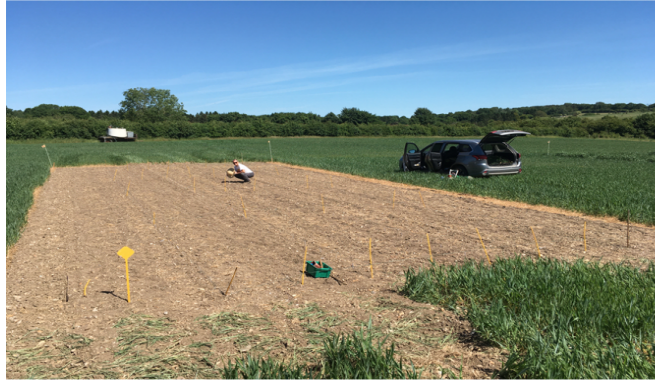
~50%



T. monococcum introgression field trial 2020

29th May - 1st June hand planted out 900 + seedlings from glasshouse

7th July 2020 – 40 days old



**BC₁ (self)
generation**



20th August 2020 – 88 days old



**Hand harvested
mid – late Sept**



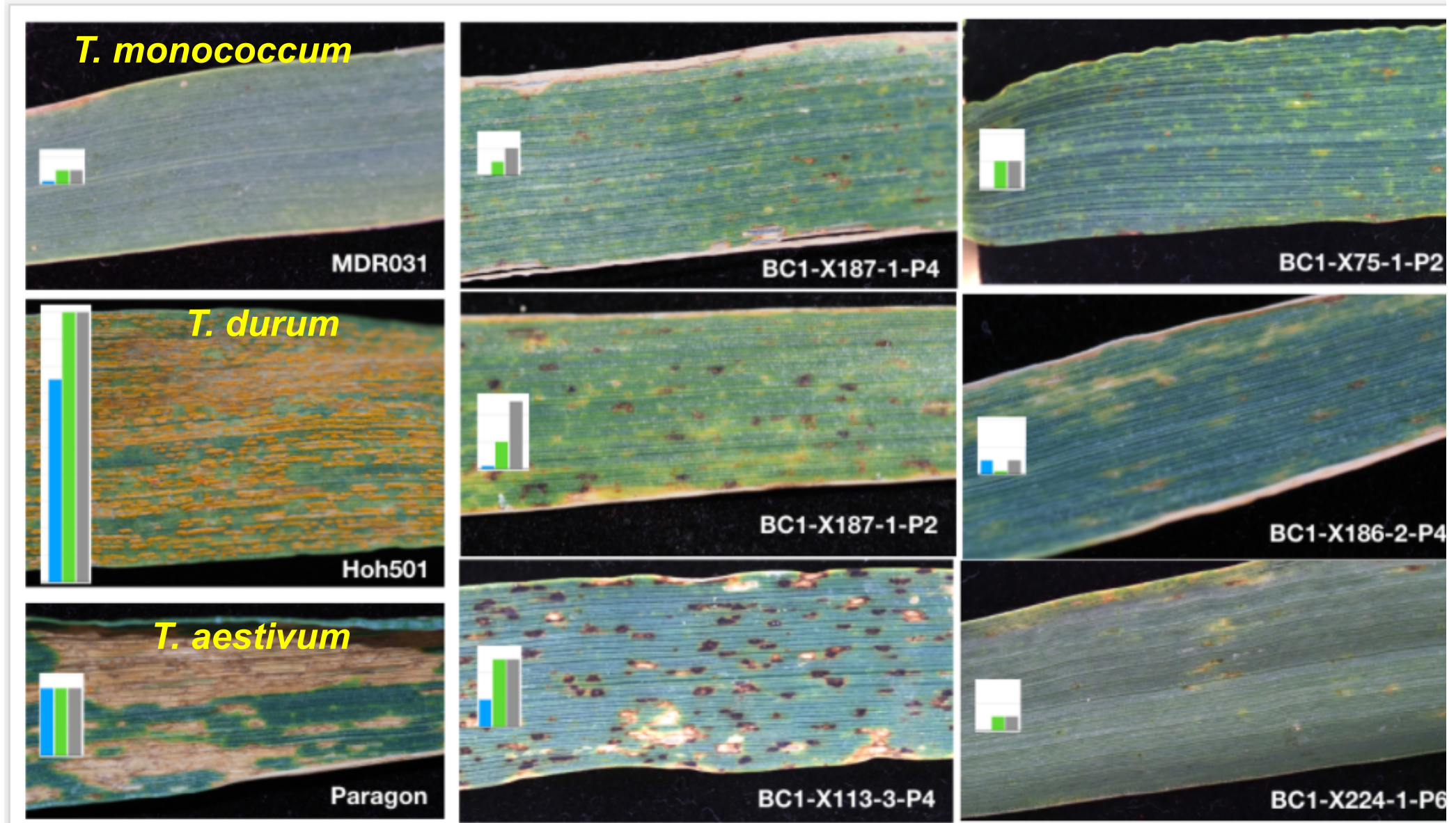
20th June 2020 – 23 days old



T. monococcum introgression field trial 2020

509 *Tm* introgression plants
scored + ~350 control plants

6 plants \leq 10% Yr disease
~ 50 plants \leq 25% Yr disease



The Networking objectives

**Maintaining and enhancing the
public – private network**

9 activities

The Defra WGIN: Dissemination, Liaison and Communication

Annual “Stakeholders’ Forum” (Nov) 70-100 attendees

Focussed Workshop – 2009, 2013 ‘A x C mapping popⁿ’

2010 – DArT marker analysis

Workshops with overseas partner organisations:

Seven funded by BBSRC (2018 – Kazakhstan, 2022? - Baltic)

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

Scientific publications ~ 87 articles

Annual displays at ‘Cereals’

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

Twitter Handle - **@WheatGIN**

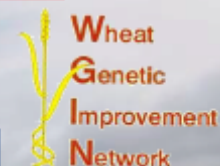


Read more about WGIN4 go to the **April 2019 Newsletter**



Department
for Environment
Food & Rural Affairs

Wheat Genetic Improvement Network (WGIN4) 2018-2023



WP1 Management Meetings – The Network

**Red text
- new to
WGIN 4**

WP1 Enhancing the Network and Communication of Results

- **AHDB strategic and monitor farms**
- Website
- Annual Stakeholders forum
- International collaborations
- Electronic Newsletter
- Focussed UK/intl. workshops
- Public outreach
- Publications + data deposits

WP2 Tools and Resources

- Maintain and further develop, mapping popⁿ, Paragon lib, Watkins/Gediflux, *T. monococcum* collections
- **Observation plots on candidate cultivars**
- Complete the A x C NIL TILING popⁿ / CSSL
- Complete the *T. monococcum* introgression
- **Sequence and assemble *T. monococcum* Chr 7A**
- **Trait related gene-specific marker development (KASP) from the PROMOTOME capture and WAK capture exps**

WP4 Genetic and QTL Analyses

for each of the targeted traits (WP3)

WP3 Targeted Traits

Improving Crop Resilience (30%)

- **BYDV resistance, slug resistance**
- Take-all resistance and **3N re-rooting**
- Septoria and yellow rust resistance

Yield Stability / Sustainability (25%)

- Spring drought tolerance
- **Lodging resistance, stem anchorage**

Enhanced Resource Use Efficiency (20%)

- Nitrogen use efficiency (NUE)

Quality Resilience (25%)

- Yield-to-grain protein, NUE
- **Nutrient partitioning vis N-input and disease**

Fine Phenotyping at Multiple Scales

Sub-Contractors – NGS Genome / Exome Analyses / Yellow Rust Races

[red text - new to WGIN4]

[black text - continuing from WGIN3]

**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
Kostya Kanyuka
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***

The Management team

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

Former RRes colleagues

**Vanessa McMillan
Gia Aradottir**

Affymetrix (35K wheat breeders array)

***new WGIN 4**

T. monococcum introgression field trial 2020

What traits were successfully scored ?

Yellow Rust assessments on flag leaf and 2nd leaf

Septoria leaf blotch – none

Aphid infestations Focus R2#2-7 vs MDR049 – not possible, very low aphids

Ear morphology – photograph of 1st ear into anthesis for each plant

Ear glossy or non-glossy (waxy)

Awn absence / presence and length

Growth stages GS 22 to GS65 (Zadoks)

Flag leaf length*

Leaf senescence post anthesis *

* Jess Hammond (RRes apprentice)

Total number of flowering tillers / plant

- instead total number of harvested ears per plant

Plant heights* and peduncle lengths*

Grain harvest

Grain shape – photograph of grain recovered from each plant

Total grain number per plant

Black – originally planned Red – planned but not possible Blue – additional traits scored