Opportunities to Exploit for Combinable Crop Production

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NIAB TAG

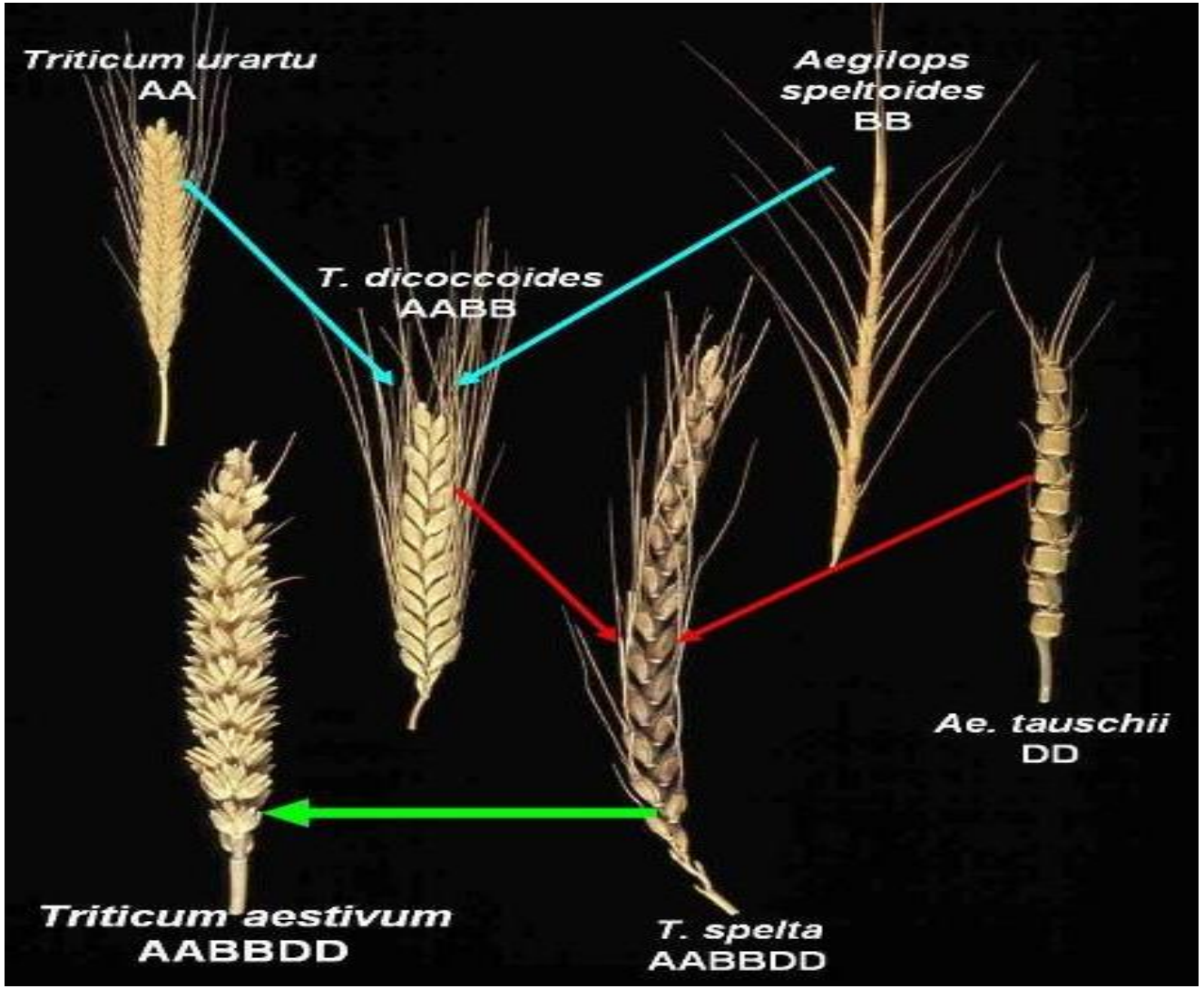
Big Challenges … but also Opportunities

Crop Improvement: Pre-Breeding

- Current breeding methods often result in trade-offs e.g. between yield and disease resistance
- Pre-breeding aims to identify new and useful genetic variation from novel sources of wheat germplasm
- Wheat Improvement Strategic Programme (WISP)
- 3 ‘pillars’ (Landrace, Synthetics and Alien-introgression)
- Higher yields, better disease resistance, drought tolerance, improved N-utilisation.

NIAB, John Innes Centre, Rothamsted Research, Universities of Bristol and Nottingham, funded by BBSRC

Middle East, approx. 10,000 years ago...



Cambridge, present day...

Durum *wheat*

X

Aegilops tauschii

‘Synthetic’ wheat

X

Elite variety

Plant Breeders
New UK varieties

New genetic diversity

Marker Assisted Breeding

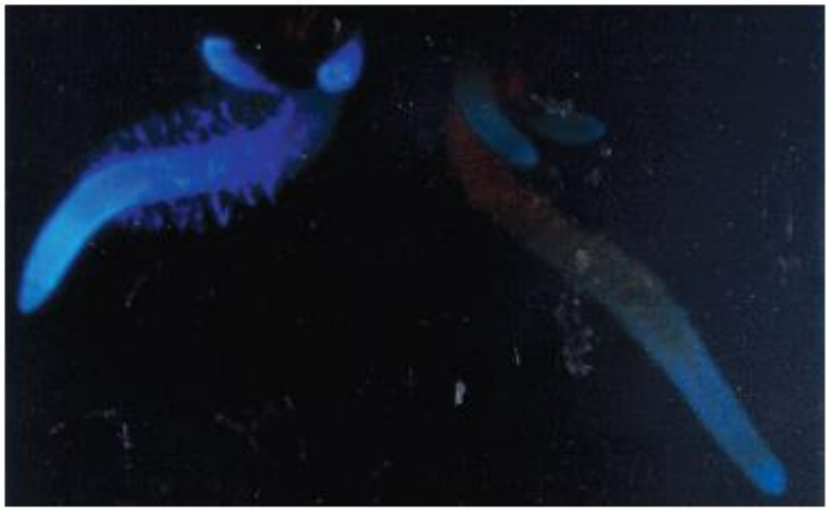
Resistance mapping and molecular marker technologies aid selection for pest / disease resistance

Currently being deployed for example in projects on bean stem nematode and oat crown rust resistance

But the resistance genes must exist in the breeding material in the first place, and the markers have to be found.

Co-funded by TSB

Metabolic Engineering: Take-all resistance



Oat seedling roots observed under UV light naturally fluoresce due to the presence of avenacin

Annual cost of take-all to UK wheat production estimated at £85-340M

Oats produce avenacin, which inhibits infection by take-all fungus

No other cereal has been found to produce this. To date no effective resistance identified in wheat

Oats too far removed from wheat for traditional crossing; only way to introduce genes is via GM route

John Innes Centre and NIAB, funded by BBSRC

Detection and Diagnostics: Diseases

Antibody-based

e.g. Lateral flow devices

Rapid, simple

Non-DNA

Metabolomics

Proteomics

Crowd-sourcing

DNA-based

Portable real-time PCR (polymerase chain reaction)

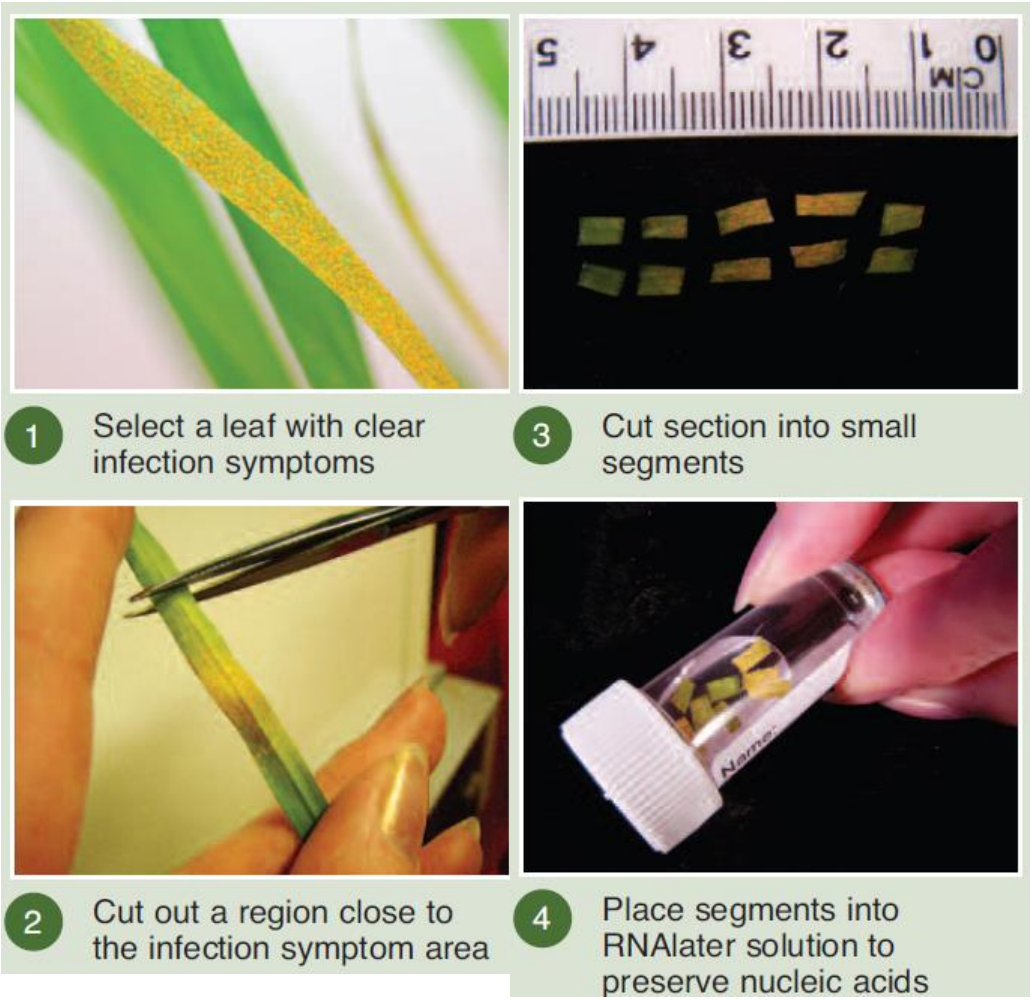
LAMP: Loop-mediated isothermal AMPlification

More sensitive

Next generation sequencing

Identify new pathogens (genomics, metagenomics)

Field Pathogenomics: Yellow Rust



Next generation sequencing being used to study how races evolve and spread

Current surveillance relies on field observation and lab virulence tests (UKCPVS)

Molecular advances mean data on genetic makeup of individuals can be integrated

Sequence the ‘transcriptome’ (genes turned on in cell) directly from field samples

John Innes Centre, The Sainsbury Laboratory and NIAB, funded by BBSRC

BioControl: Black-grass

Plated black-grass seed: most colonies are likely to be harmless saprophytes, but some may be pathogenic and able to colonise seed and reduce viability.

Mycoherbicides: use of pathogenic fungi to control weeds

Two main approaches:

- Release into environment. Must survive and re-infect every year
- Apply each year in same way as herbicide (does not persist)

Must be no cross-infection onto cereals or beneficial grasses

Must be able to survive in arable environment (*e.g.* fungicide sprays)

Funded by CRD

Straw Burning!

% reduction in plants or viable seeds from cultural control measures and resulting % control of **plants** required by herbicides in continuous wheat drilled in late September.

Burn	Plough	3 week delay in drilling	Increased crop competition	**% herbicide control required**
0%	0%	0%	0%	**97%**
0%	70%	30%	50%	**71%**
40%	70%	30%	50%	**52%**
70%	70%	30%	50%	**5%**

Orson and Cussans 2014

Targeted Application of Herbicides

New weed control solutions to address loss of herbicides, changes to approvals or resistance

Figure 1. Experimental machine working to spot spray mugwort (*Artemisia vulgaris*) in a leek crop

Silsoe Spray Applications Unit and Tillett & Hague Technology, funded by Horticulture LINK

Inter-row spraying for black-grass control in winter oilseed rape

NIAB TAG and SRUC, Funded by AHDB-HGCA

Unmanned Aerial Systems

- Fixed and rotary wing (drones, micro-planes, hexacopters)
- Rapidly deployable enabling data to be collected at critical stages
- Flexible payloads (sensor and camera technologies
- Needs robust algorithms to extract and interpret information
- Opportunity for on-farm monitoring
- Spatial resolutions provide level of detail needed to assess plots

Most important part of any innovation:

NIAB

BBSRC bioscience for the future

LINK collaborative research

Chemicals Regulation Directorate (CRD)

AHDB Agriculture & Horticulture DEVELOPMENT BOARD

HGCA

Technology Strategy Board
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