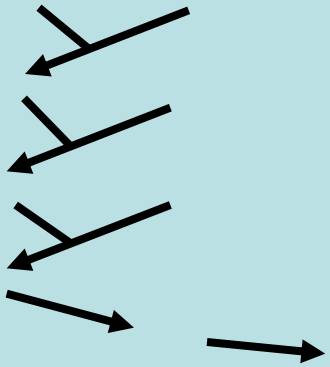
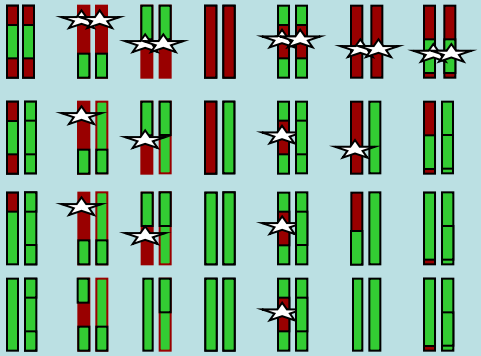
WGIN2 JIC Update

Management meeting Aug ‘10

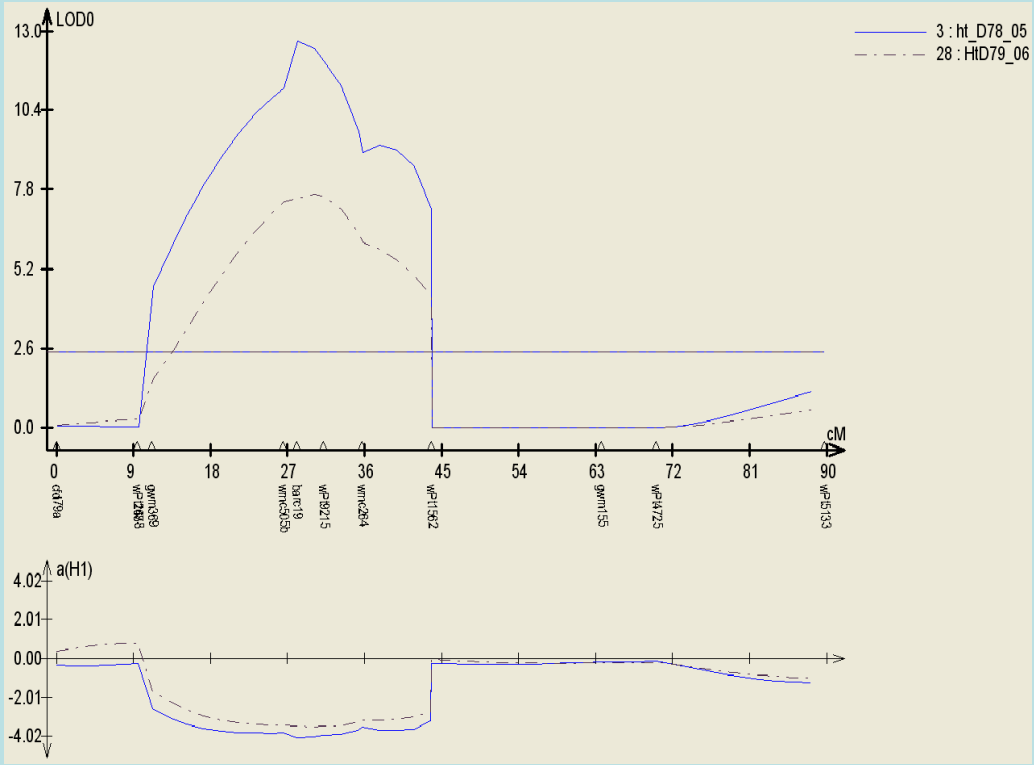
Development of Near Isogenic Lines

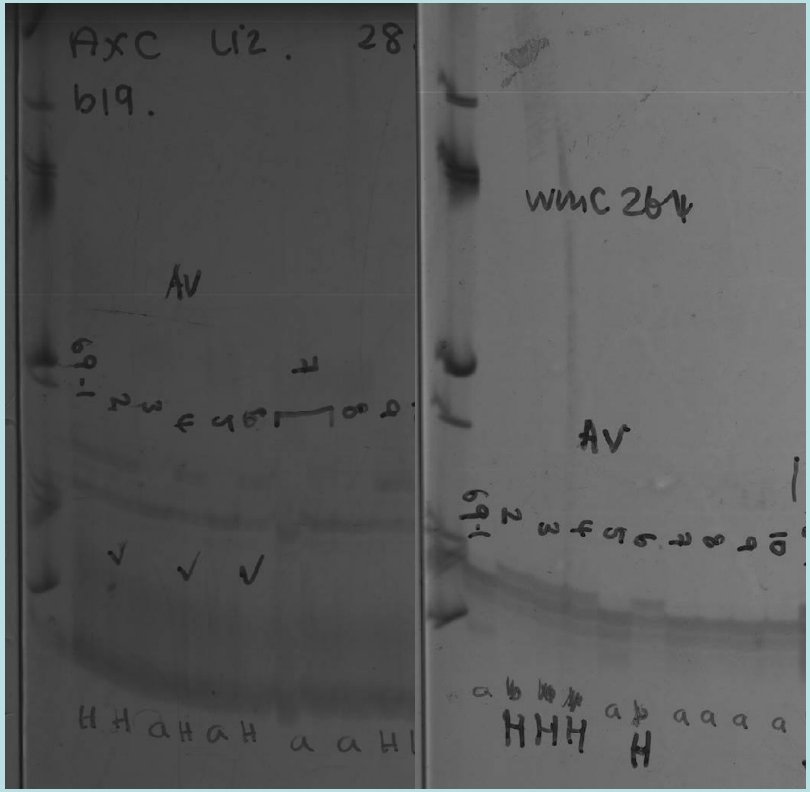
Near Isogenic Line development
-Example of strategy for 3A height





WGIN1 → WGIN2





Avalon x Cadenza introgression segments- validation of allelic difference?
Now selecting homozygotes from selfed BC_2

1B	wmc44-barc80	
1D	gdm11-wmc93	
2A	barc124b-gwm122	
2D	gwm261-cfd36	
3A	wmc264-barc19	Some validation
3B	wm389-gwm493-barc75	
3B	cfd79b-wmc326	
6A	barc171-barc23a-gwm570	
6B	gwm219-wmc105	
7B	barc176-wmc517-gwm577	
7D	cfd21a-gwm437-psp3113	

Development of *Lr19/Sr25* NILs

Why – Lr19 on segment of *Agropyron elongarum* translocation to 7DL, as well as disease resistance CIMMYT breeders identified a yield advantage in some environments.

CIMMYT donors:

- Wheatear
- Kambari 1
- Oasis- no pigment

UK recurrent parents:

- Alchemy
- Paragon

Progress:

- BC_2 heterozygotes selfed
- Selection with dominant marker
- WGIN COS are co-dominant so ideal for selection of homozygotes

AE Watkins and population development

Ten AE Watkins x Paragon SSD populations- now at F_4

- Extremes- height and ear emergence. Ten SSD populations up to F_5 plants in large pots, five ears bagged, 8 fully on track, the other two have winter type stragglers!

- Thousand grain weight, grain length and grain width measured on 1100 Watkins lines. Data available on WGIN website.

- Also 2 SSDs Paragon X CS and JIC synthetic up to F_4. F_6 seed now sown and DNA extracted from F5. Already used for mapping.

- 1071 Watkins accessions in grown in soil house and at Church Farm, senescence scores taken by John Foulkes

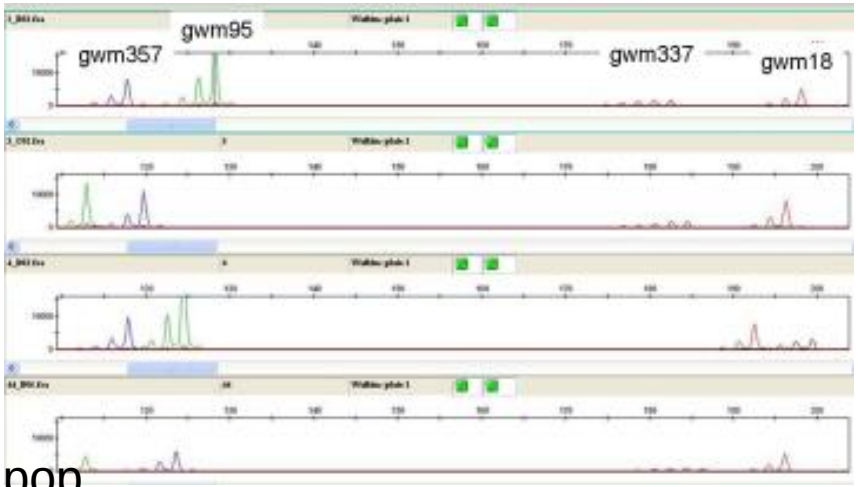
- Watkins DNA extracted

Drought population development

- 9th April meeting hosted by RAGT to discuss use of outputs from drought LINK
- Complex data set but some varieties with interesting characteristics
- WGIN will make F1s with a range of parents inc:
- Claire, Consort, Gatsby, Paragon, Timber, Zebedee, Garcia
- Further discussion to settle on strategy

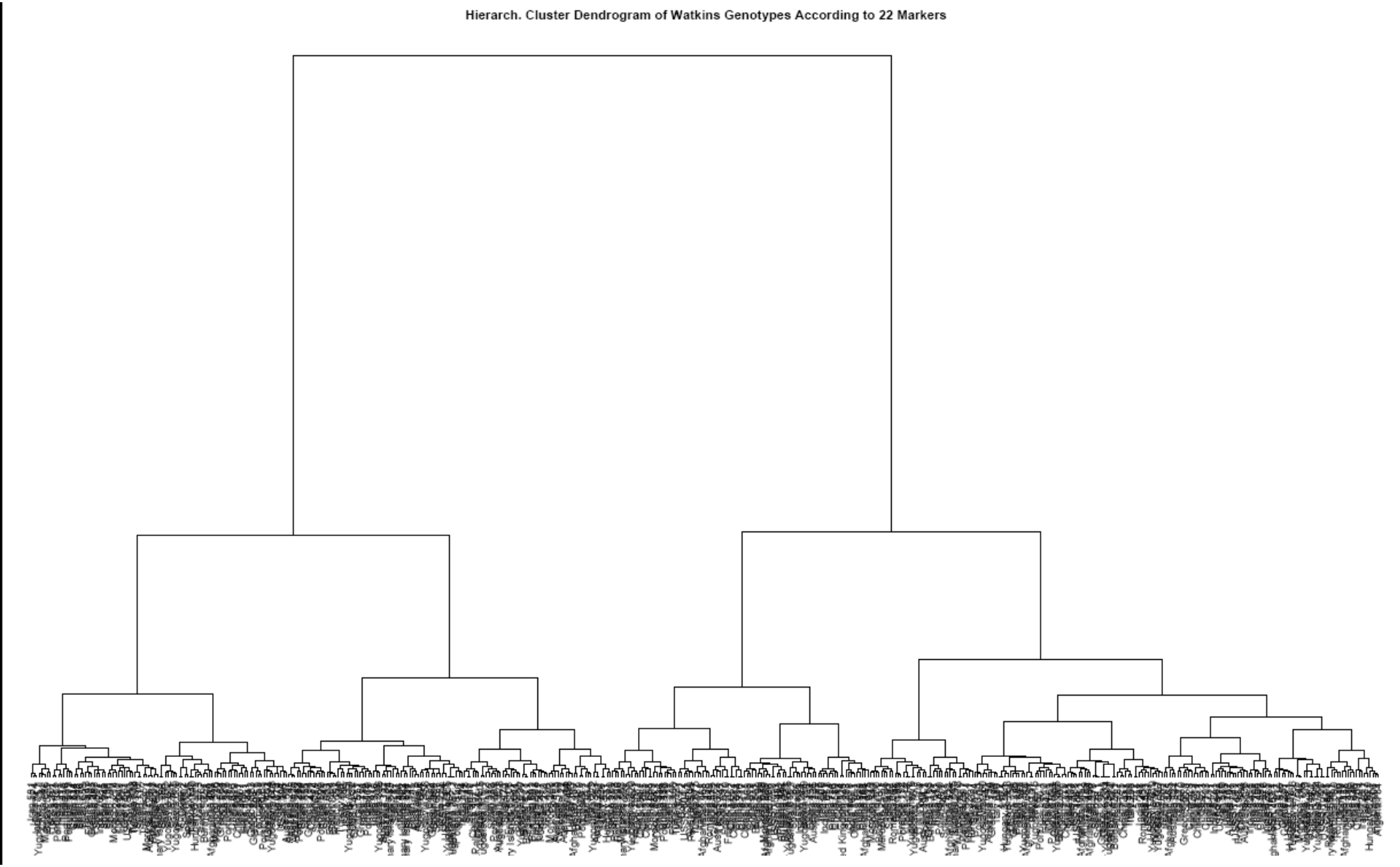
Development of AE Watkins genotyped core sets

•Originally proposed DArT but more efficient to go for SSRs in anticipation of NGS profiling of relatively small (initially) core sets.



• 59 SSRs and 4 COS on full pop

Representative cluster analysis of AE Watkins genotypes



WGIN at JIC

Catherine Baker

Liz Sayers

Richard Goram

Luzie Wingen

Simon Orford

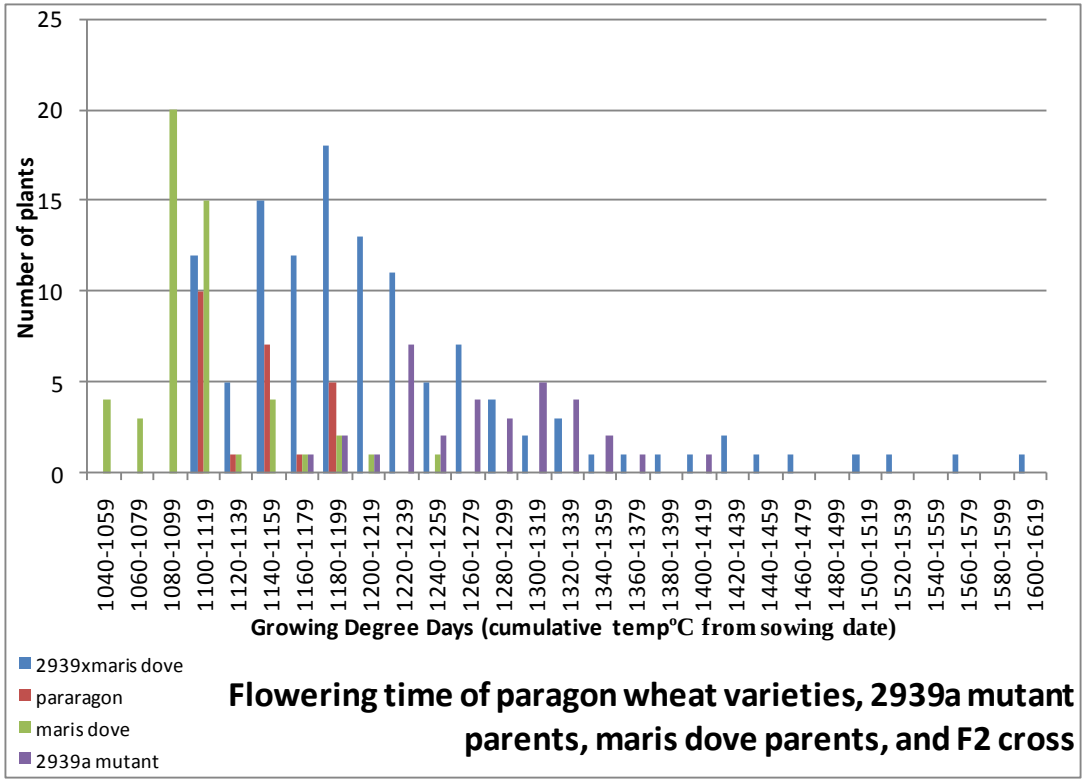
Michelle Leverington

John Snape

Lesley Fish

Debora Gasperini

Segregation of ear emergence for 2939a



Heading date DArT data returned for heading date

- 2939a mutant was crossed with Maris Dove
- 2939a mutant was crossed with Wembley
- 423a mutant was crossed with White Fife
- 423a mutant was crossed with Koga

Taking Paragon EMS alleles forward

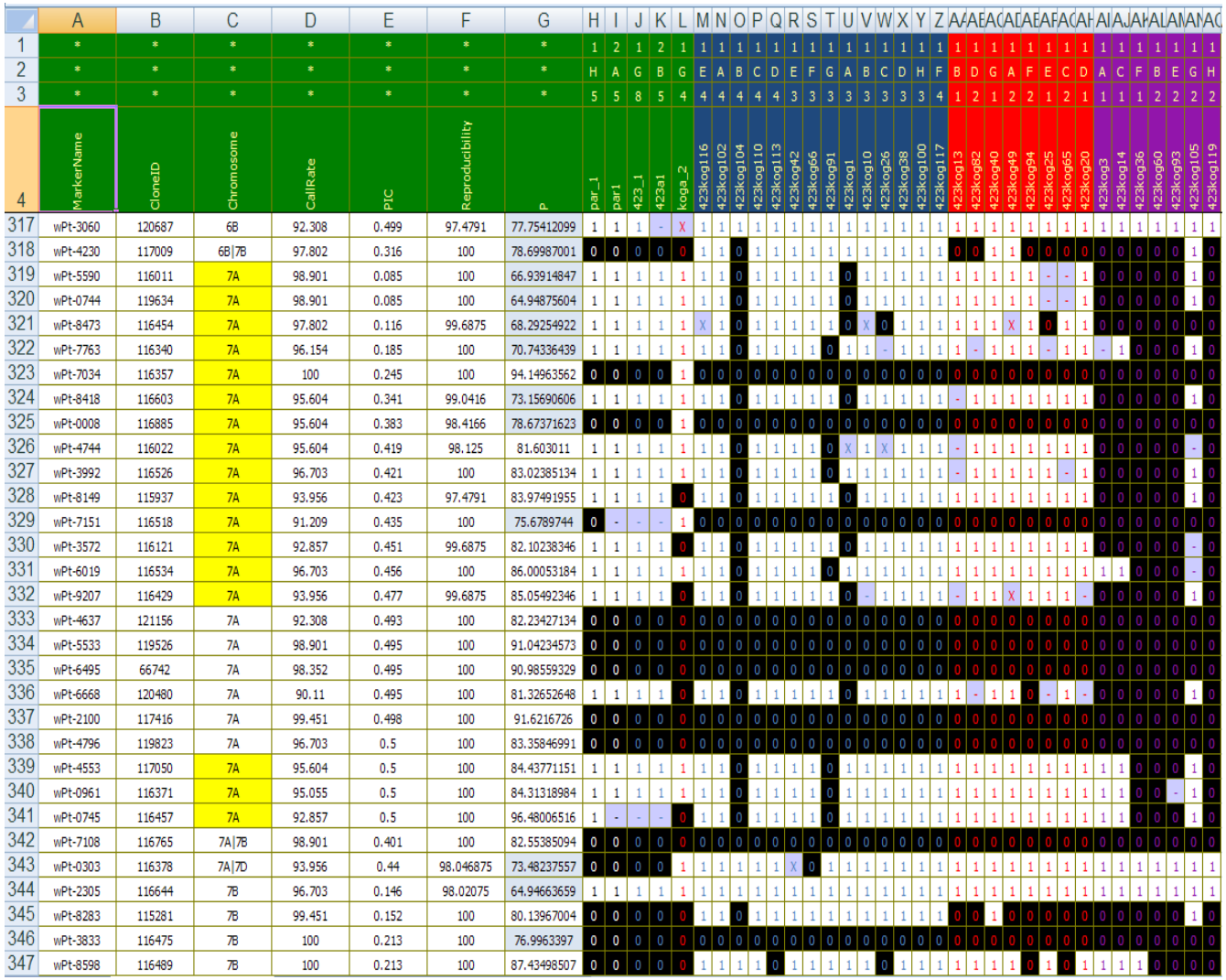
Leaf senescence segregating

Tagging plants by visiting students for DNA collection and trait scoring

Mutant x Spring cultivars: F_2 families
12 families – segregations of mutant types height, flowering, leaf senescence and biomass

Paragon mutants in Hege 80s
Left – flowering time differences (first two plots) Right – leaf senescence

Grp 7 associations for 423a



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO
1	*	*	*	*	*	*	*	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	*	*	*	*	*	*	*	H	A	G	B	G	E	A	B	C	D	E	F	G	A	B	C	D	H	F	B	D	G	A	F	E	C	D	A	C	F	B	E	G	H
3	*	*	*	*	*	*	*	5	5	8	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	4	1	2	1	2	2	1	2	1	1	1	2	2	2	2
4	MarkerName	CloneID	Chromosome	CallRate	PIC	Reproducibility	P	par_1	par1	423_1	423a1	koga_2	423kog116	423kog102	423kog104	423kog110	423kog113	423kog42	423kog66	423kog91	423kog1	423kog10	423kog26	423kog38	423kog100	423kog117	423kog13	423kog82	423kog40	423kog49	423kog94	423kog25	423kog65	423kog20	423kog3	423kog14	423kog36	423kog60	423kog93	423kog105	423kog119
317	wPt-3060	120687	6B	92.308	0.499	97.4791	77.75412099	1	1	1	-	X	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
318	wPt-4230	117009	6B|7B	97.802	0.316	100	78.69987001	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0
319	wPt-5590	116011	7A	98.901	0.085	100	66.93914847	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	-	-	1	0	0	0	0	0	1	0
320	wPt-0744	119634	7A	98.901	0.085	100	64.94875604	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	-	-	1	0	0	0	0	0	1	0
321	wPt-8473	116454	7A	97.802	0.116	99.6875	68.29254922	1	1	1	1	1	X	1	0	1	1	1	1	1	0	X	0	1	1	1	1	1	1	1	X	1	0	1	1	0	0	0	0	0	0	0
322	wPt-7763	116340	7A	96.154	0.185	100	70.74336439	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	-	1	1	1	1	1	-	1	1	1	-	1	0	0	0	1	0
323	wPt-7034	116357	7A	100	0.245	100	94.14963562	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
324	wPt-8418	116603	7A	95.604	0.341	99.0416	73.15690606	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	-	1	1	1	1	1	1	1	0	0	0	0	0	1	0
325	wPt-0008	116885	7A	95.604	0.383	98.4166	78.67371623	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
326	wPt-4744	116022	7A	95.604	0.419	98.125	81.603011	1	1	1	1	1	1	1	0	1	1	1	1	0	X	1	X	1	1	1	-	1	1	1	1	1	1	1	0	0	0	0	0	-	0
327	wPt-3992	116526	7A	96.703	0.421	100	83.02385134	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	-	1	1	1	1	1	-	1	0	0	0	0	0	1	0
328	wPt-8149	115937	7A	93.956	0.423	97.4791	83.97491955	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	0
329	wPt-7151	116518	7A	91.209	0.435	100	75.6789744	0	-	-	-	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	wPt-3572	116121	7A	92.857	0.451	99.6875	82.10238346	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	-	0
331	wPt-6019	116534	7A	96.703	0.456	100	86.00053184	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	-	0
332	wPt-9207	116429	7A	93.956	0.477	99.6875	85.05492346	1	1	1	1	0	1	1	0	1	1	1	1	1	0	-	1	1	1	1	-	1	1	X	1	1	1	-	0	0	0	0	0	1	0
333	wPt-4637	121156	7A	92.308	0.493	100	82.23427134	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
334	wPt-5533	119526	7A	98.901	0.495	100	91.04234573	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
335	wPt-6495	66742	7A	98.352	0.495	100	90.98559329	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
336	wPt-6668	120480	7A	90.11	0.495	100	81.32652648	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	-	1	1	0	-	1	-	0	0	0	0	1	0
337	wPt-2100	117416	7A	99.451	0.498	100	91.6216726	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
338	wPt-4796	119823	7A	96.703	0.5	100	83.35846991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
339	wPt-4553	117050	7A	95.604	0.5	100	84.43771151	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0
340	wPt-0961	116371	7A	95.055	0.5	100	84.31318984	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	-	1	0
341	wPt-0745	116457	7A	92.857	0.5	100	96.48006516	1	-	-	-	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0
342	wPt-7108	116765	7A|7B	98.901	0.401	100	82.55385094	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
343	wPt-0303	116378	7A|7D	93.956	0.44	98.046875	73.48237557	0	0	0	0	1	1	1	1	1	1	X	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
344	wPt-2305	116644	7B	96.703	0.146	98.02075	64.94663659	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
345	wPt-8283	115281	7B	99.451	0.152	100	80.13967004	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
346	wPt-3833	116475	7B	100	0.213	100	76.9963397	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
347	wPt-8598	116489	7B	100	0.213	100	87.43498507	0	0	0	0	0	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0

‘Late late’ 423a

Gamma M_1 mutants:
CS bagged left (2500) sown). Paragon (2000 sown) currently bagging right
50% fertility rate expected

Now harvested M_2 seed- for sowing in spring 2010
Scope for a further 4000

Koga 7A nullisomics

Gamma mutagenesis

Crop Improvement Research Club Update for WGIN

Jayne Brookman, Simon Bright,

CIRC Co-ordination

Biosciences KTN

BBSRC bioscience for the future

Knowledge Transfer Network Biosciences

The Scottish Government

Context

- Global challenges of food security and climate change
- UK strategy for food security
  - www.foodsecurity.ac.uk
  - BBSRC leads for research councils
- Drive towards greater translation of research results
  - Impact agenda
  - Partnerships with industry

BBSRC: Industry Clubs

- Industry club funds leveraged by BBSRC
  - Research agenda tailored with club members
  - Science base attacks the research challenges
  - Strong co-ordination and networking
- Successful model already
  - BRIC, DRINC, IBTI
  - Crop Improvement Club has additional funding from Scottish Government

BBSRC bioscience for the future

CIRC • CROP IMPROVEMENT RESEARCH CLUB

Knowledge Transfer Network Biosciences

Crop Improvement Club

VELCOURT
Europe's Leading Farming Company

United Oilseeds

HGCA

The Scotch Whisky Research Institute

nabim

MONSANTO imagine™

Limagrain United Kingdom

Campden BRI
food and drink innovation

R·A·G·T

KWS
Seeding the future since 1856

BASF
The Chemical Company

syngenta SEEDS

Elsoms

SECOBRA recherches

BBSRC
bioscience for the future

CIRC • CROP IMPROVEMENT RESEARCH CLUB

Knowledge Transfer Network
Biosciences

Research Challenges

- Crops: Wheat, Barley, Oilseed Rape
- Targets: Productivity
  - Sustainable high yields with lower inputs
    - Yield potential, pest and disease resistance , resource efficiency
- Targets: Quality
  - Wheat, barley functionality and consistency

Benefits to research groups

- Basic research with translation in mind
  - BBSRC quality standards and processes
- Additional studentships available to successful grantholders
- Network building
  - Industry links within the club
  - Co-ordination and dissemination externally
    - Biosciences KTN Plant Sector
    - Support to access follow-on funding sources

BBSRC bioscience for the future

CIRC • CROP IMPROVEMENT RESEARCH CLUB

Knowledge Transfer Network Biosciences

Part of the bigger picture

- Business engagement with research
  - Industry Partnership Awards (BBSRC)
  - Knowledge transfer partnerships (TSB)
  - Sustainable Agriculture Innovation Platform (TSB)
- Training and skills
  - Advanced Training Partnerships (BBSRC)
- Culture change towards translation of research

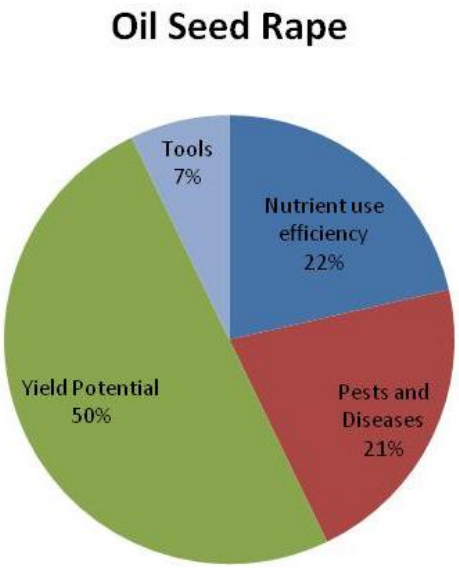
Research Challenges

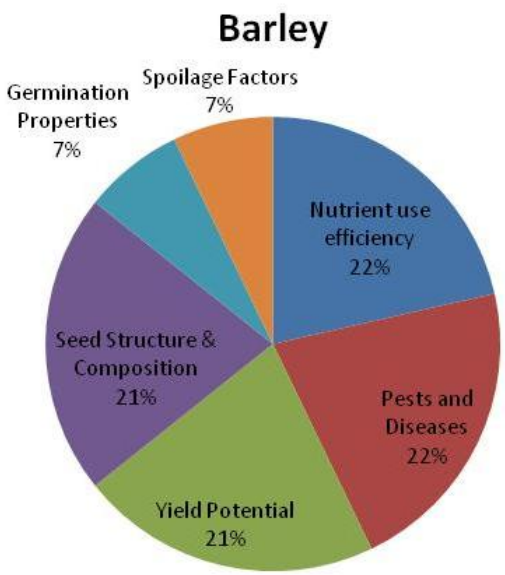
- Crops: Wheat, Barley, Oilseed Rape
- Targets: Productivity
  - Sustainable high yields with lower inputs
    - Yield potential, pest and disease resistance , resource efficiency
- Targets: Quality
  - Wheat, barley functionality and consistency

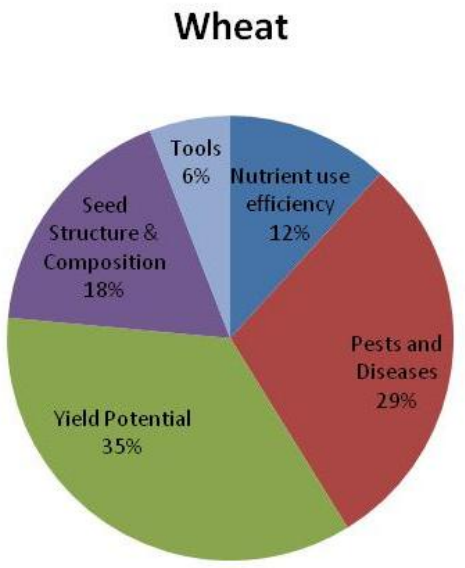
First Call- Outline Applications

46 total- 14 OSR, 14 Barley, 17 Wheat

16 invited – 6 OSR, 3 Barley, 7 Wheat







The applications received were assigned categories (for interest and information only) based on crop and research priority

BBSRC bioscience for the future

CIRC • CROP IMPROVEMENT RESEARCH CLUB

Knowledge Transfer Network Biosciences

First call- full applications

- Early September deadline for full applications
- Feedback from referees Jan 2011
- Committee 1st March 2011
- April award date
- 2nd Call Spring 2011

CIRC Co-ordination team

- Maximise impact
- Support the delivery and reporting of the projects
- Support the further development of the club

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ROTHAMSTED RESEARCH

Wheat Genetic Improvement Network

Eyespot resistance in the Watkins collection

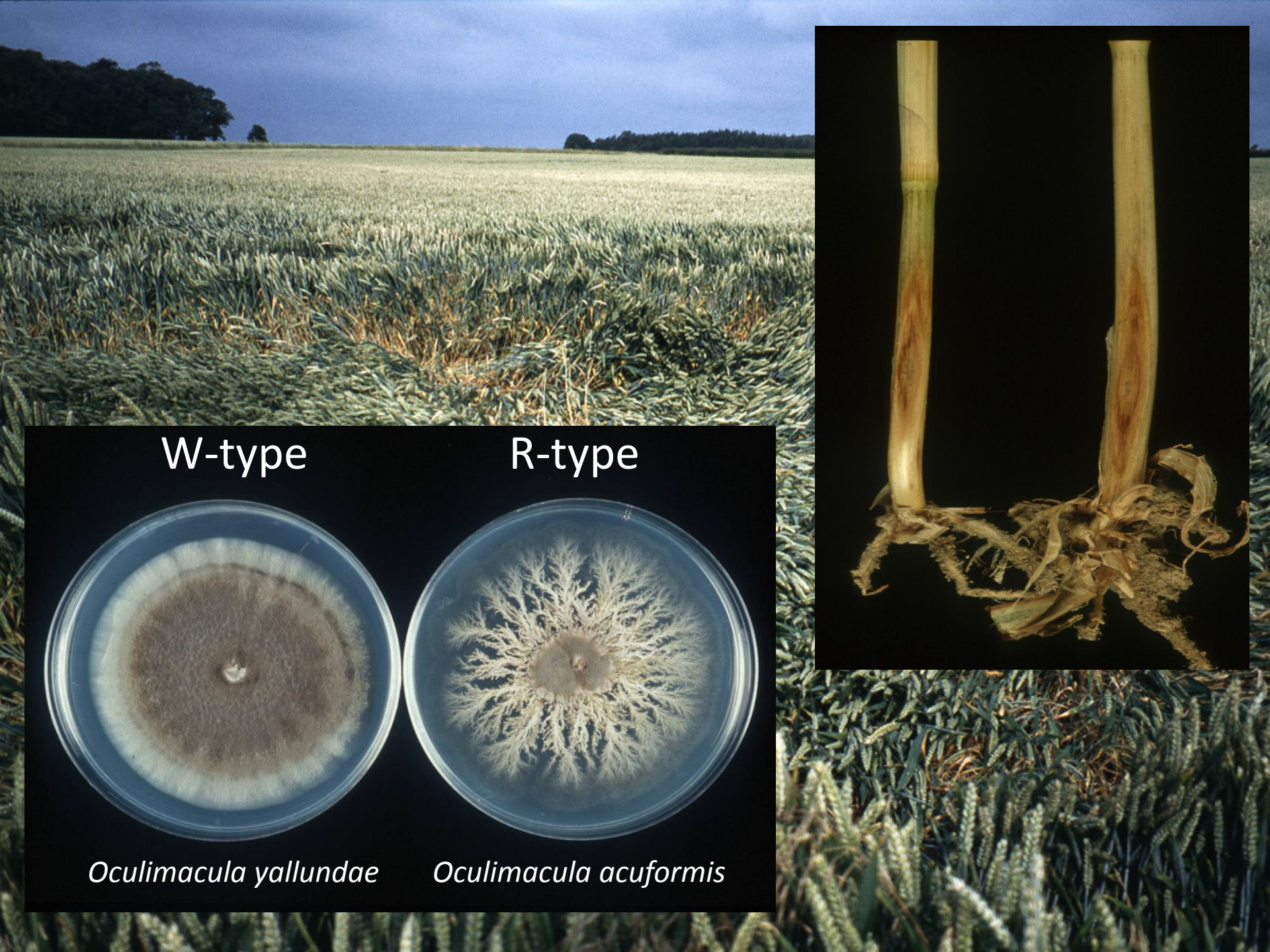
WGIN Management Group Meeting

JIC 12th August 2010

Chris Burt and Richard Gutteridge

BBSRC bioscience for the future

John Innes Centre


W-type
R-type
Oculimacula yallundae
Oculimacula acuformis

Eyespot Disease

Most common stem base disease of wheat in UK

Reduced UK wheat yield by 1.2 % in 2008

>250,000 tonnes

9 million loaves

Eyespot Resistances and Markers

Resistance	Source	Effect	Markers
Pch1	*Aegilops ventricosa*	Potent *O. yallundae* + *O. acuformis* Seedling + Adult	WGIN-COS7S (Burt et al., in prep) Orw1 (Leonard et al., 2008)
Pch2	Cappelle Desprez	Moderate *O. acuformis* Seedling	Wmc525 (Chapman, Burt et al., 2008) Cfa2040 (Chapman, Burt et al., 2008)
5A QTL *QPch.jic-5A*	Cappelle Desprez	Moderate *O. yallundae* + *O. acuformis* Seedling + Adult	Gwm639 (Burt et al., 2010, TAG)

All have limitations or associated problems

More resistances required

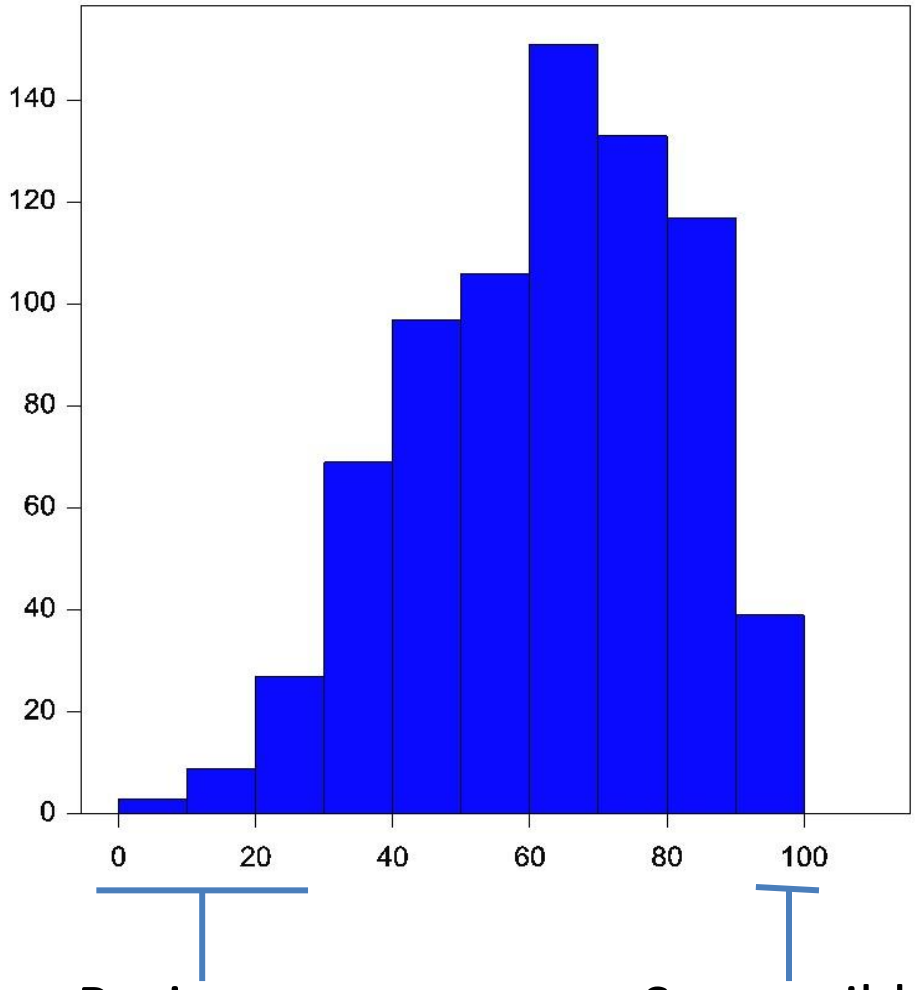
Simon Orford

Disease Resistance in Watkins Collection

- Rothamsted 2009
- 740 Watkins Collection accessions in field trial
- Alpha design
  - Single plots with 20 controls + 5 blocks x 8 replicated controls
- Take-all / Stem base diseases
- Heavy natural infection with eyespot

→ Scored for eyespot stem infection at adult stage

Susceptibility Diversity



Are there novel eyespot resistances in the Watkins Collection?

- Can this variation be explained by known eyespot resistances?
- Test “Resistant” and “Susceptible” accessions for known resistances
- Tested accessions for haplotypes associated with resistance
  - *Pch1* markers: WGIN COS7S / Orw1
    (n.b. *Pch1* introduced to wheat in 1967) } Not present
  - *Pch2* SSR markers: Wmc525 / Cfa2040
  - *Q.Pch.jic-5A* SSR marker: Gwm639

Pch2 in Watkins Collection

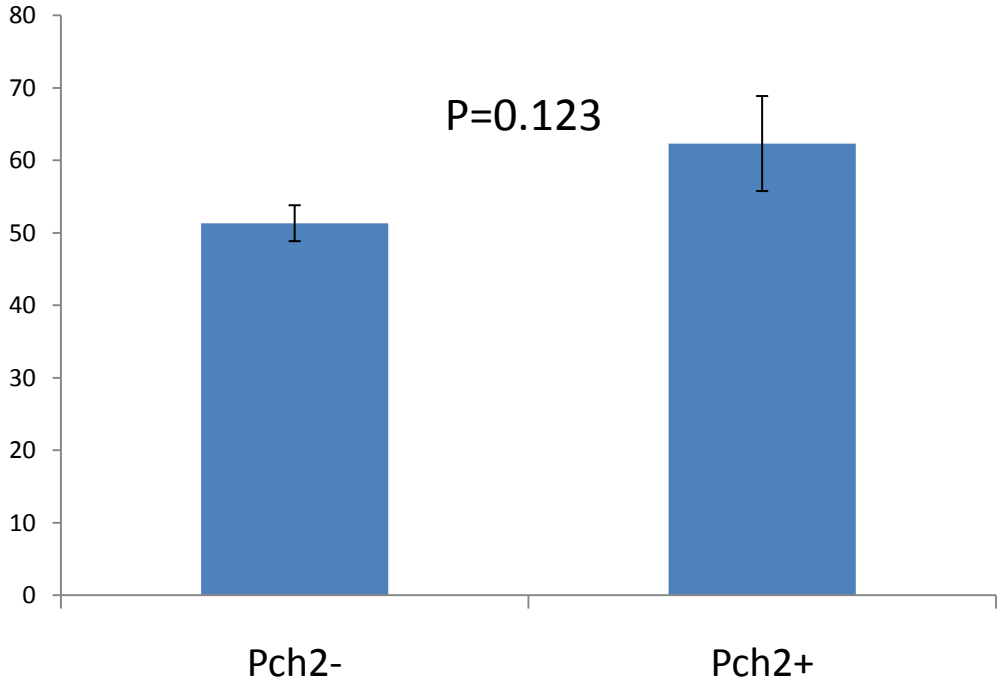
Group	*Pch2*
Resistant	2 accessions
Susceptible	5 accessions

Pch2 is present in subset of collection

No evidence of resistance differential

Pch2 is not effective at adult plant stage or against *O. yallundae*

Burt et al., (2010) Plant Pathology



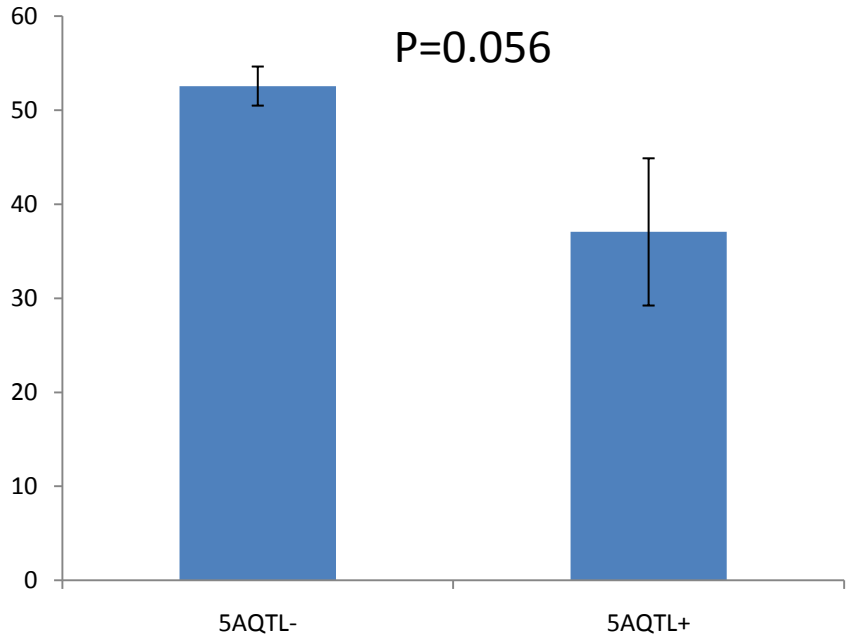
5A QTL in Watkins Collection

Group	*Q.Pch.jic-5A*
Resistant	5
Susceptible	0

5A QTL is present in collection

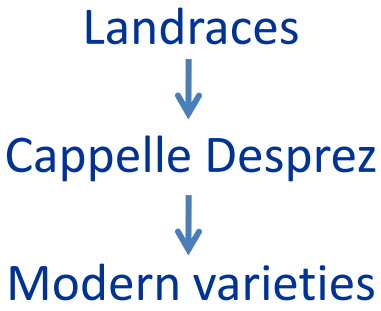
Some evidence of resistance differential

Effective at adult plant stage and both pathogen species



Conclusions

- 5A QTL is the only known resistance present and effective in the "Resistant" Watkins accessions



- Known resistances do not explain resistance observed in accessions

- Likely to be novel resistances present?
  - 1 years field trial data

Exploiting novel resistances

Validating resistance phenotypes with *O. yallundae* and *O. acuformis* inoculations independently

F_2 Population developed by Simon Orford:

Paragon
(Susceptible)
x
Watkins accession 827
(Resistant with no known resistances)

Association genetics approach to entire collection?

Acknowledgements

Richard Gutteridge

Kim Hammond-Kosack

Paul Nicholson

Simon Orford

Simon Griffiths

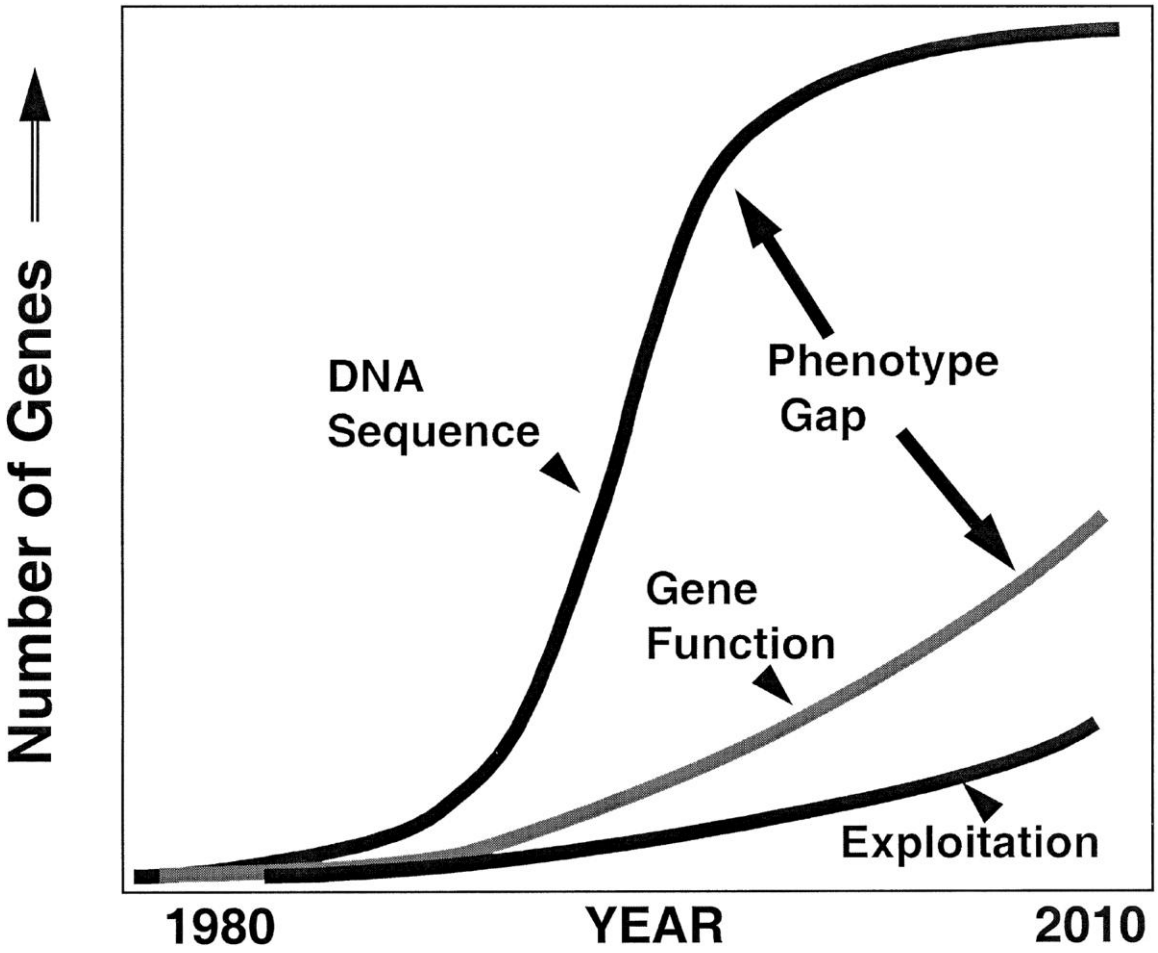
Michelle Leverington-Waite

High throughput field phenotyping

Why?
How?
What next?

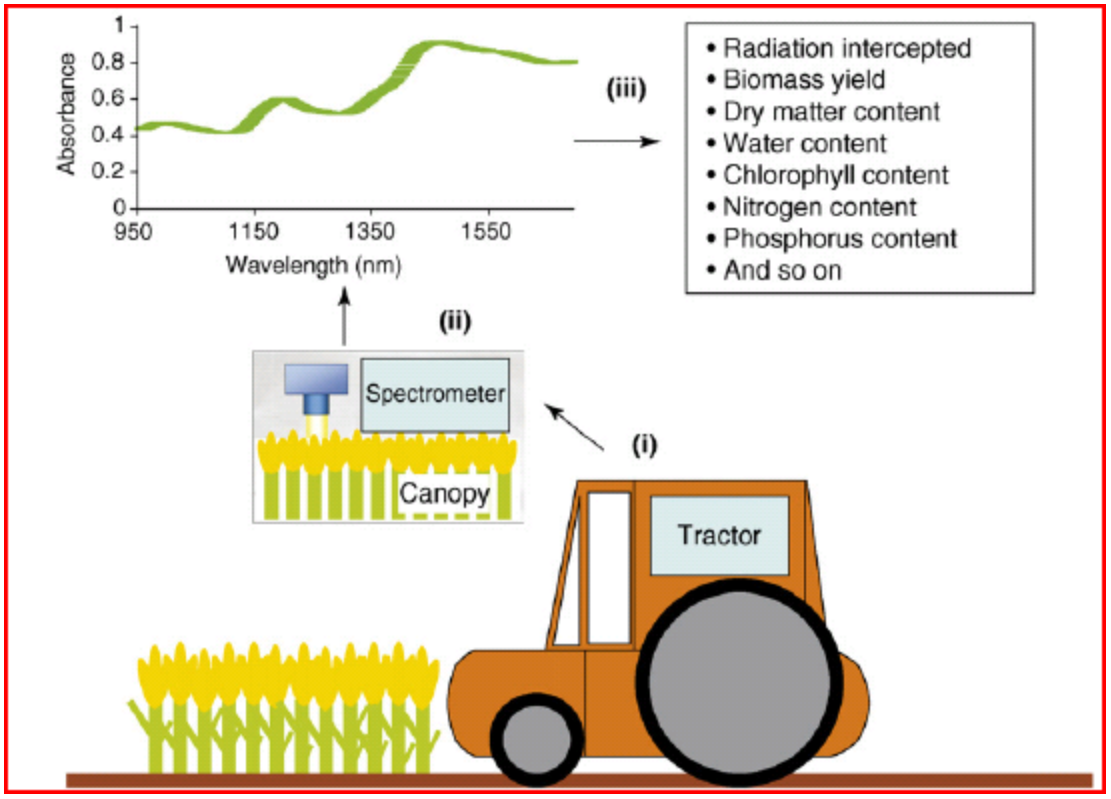
Crop improvement in the 21st century

Miflin J Expt Bot, 2000 **51**:1-8, January



"… to improve crops and to meet the challenges ahead, the genotypic view and emphasis on genomics needs to be balanced by a phenocentric approach…"

Novel throughput phenotyping platforms in plant genetic studies



"Unravelling the genetic basis of complex traits in plants is limited by the lack of appropriate phenotyping platforms that enable high-throughput screening of many genotypes in multi-location field trials."

Montes et al.
TIPS 2007 12:433- 436

Why?

Large experiments:

GWAS
NAM
MAGIC

Plants grown under artificial conditions do not display the same characteristics as in natural conditions:

Soil
Climate
Interactions between plants

Multiple genes interacting over time and environment:

need for repeated measurements

Example: functional mapping

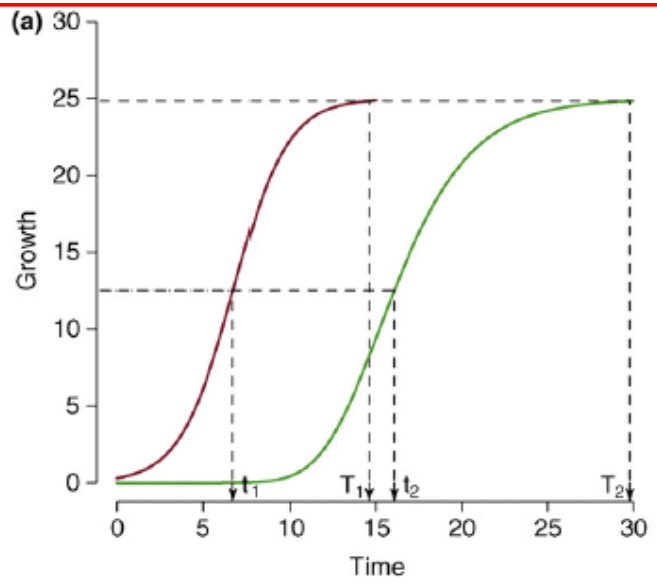
He et al TIG 2009 **26**:39-46

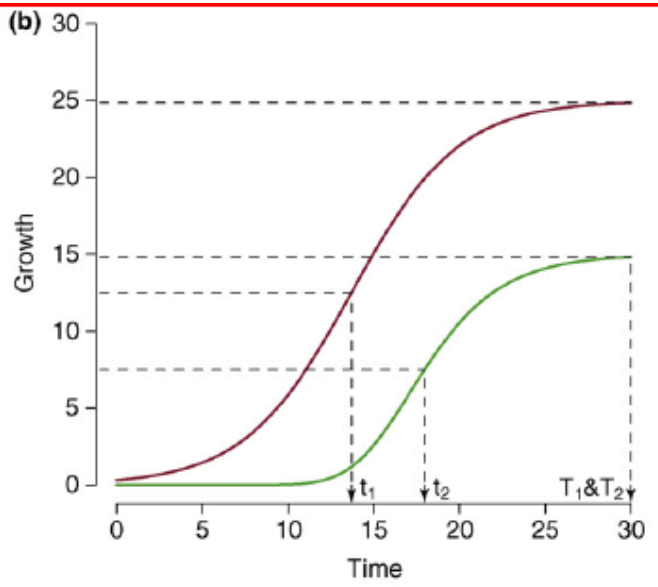
Faster: slower

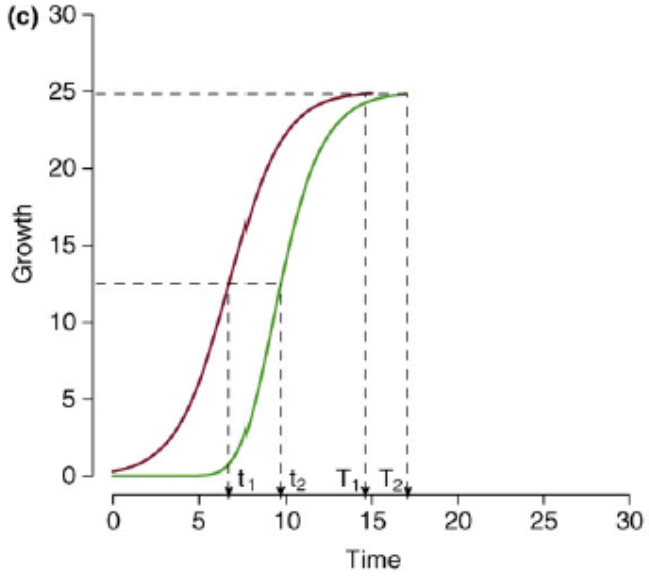
Bigger: smaller

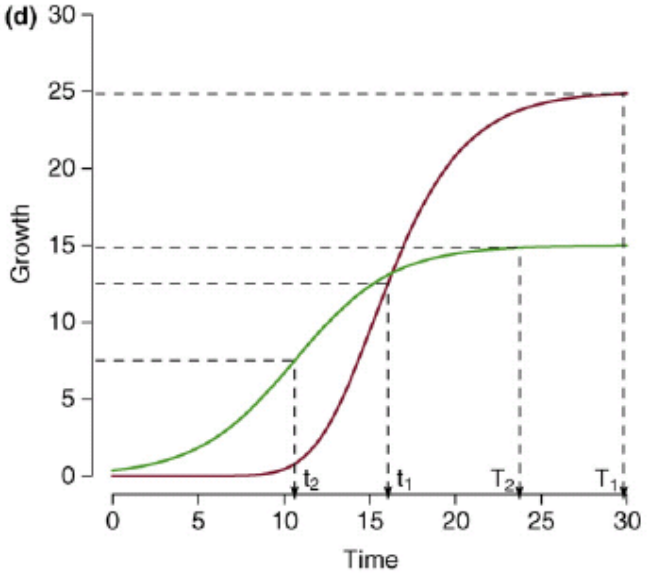
Earlier: later

Age dependent bigger: smaller









Why not use LemnaTec

Platform is going to have a major impact, but:

Relevance:

single pot grown plants

Scale:

single plants
glasshouse occupied for the duration of the experiment

Phenotype to genotype: Development of 'deep' phenotyping capacity for cereal crop breeding

Sheffield, NIAB and Nottingham

Strategic LOLA going to full proposal

1. develop a 'deep' phenotyping capability with an emphasis on the development of technology and protocols which integrate measurements of photosynthesis (and other physiological measurements) with shoot architecture and plant growth
2. use measurements made on wheat plants growing in the field to develop deep phenotyping protocols and parameters which best predict plant performance in the field;
3. develop realistic techniques/protocols (using X-ray computed tomography) for imaging of root architecture relevant to field/soil grown plants
4. phenotype the wheat MAGIC lines in the field and in the high resolution phenotyping node and carry out comparative analyses to identify the genetic basis of traits controlling plant performance and yield;
5. develop and exchange (with colleagues in the UK and worldwide) data management solutions relating to information capture, processing and dissemination.

Phenotype to genotype: Development of 'deep' phenotyping capacity for cereal crop breeding

Sheffield, NIAB and Nottingham

Strategic LOLA going to full proposal

- Next Steps
  - Meeting of the parties, Sutton Bonington 31/8, to discuss and develop the science plan
  - Engagement with stakeholders to gather feedback and develop links
  - Submit full proposal

What is the alternative?

Static field based systems

Rain-out shelters, ICRISAT

Static field systems allow some manipulation of the environment but still limited in scale.

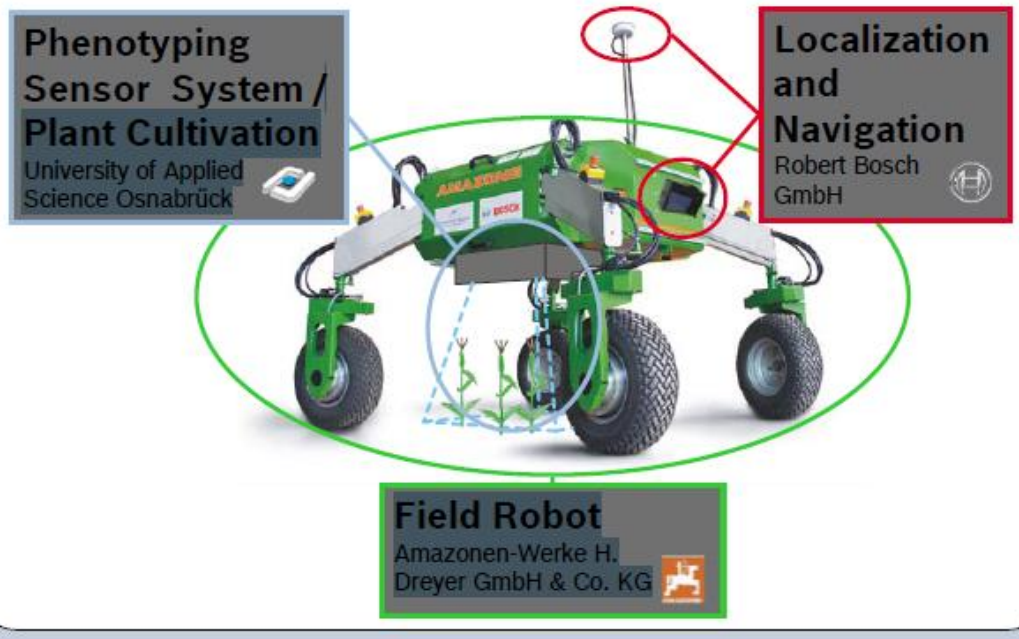
Mobile systems: BoniRob (German)

The BoniRob Project [1]

- Development of an autonomous crop scout for individual plant phenotyping (first use case is maize)
- Publicly funded by the German Agricultural Ministry, supported by the Federal Agency for Agriculture and Food (BLE)
- Academic and industrial partners
- For a period of up to 3 years (launched at April 2008)
- Robot platform
  - Omni-directional and flexible
  - Ground clearance: 40 – 80 cm
  - Track gauge: 75 – 200 cm
  - Hydraulic arms and electrical wheel hub motors

Phenotyping parameters

- Number of plants, crop density
- Spacing in the row
- Plant height
- Steam thickness
- Spectral reflection
- ...

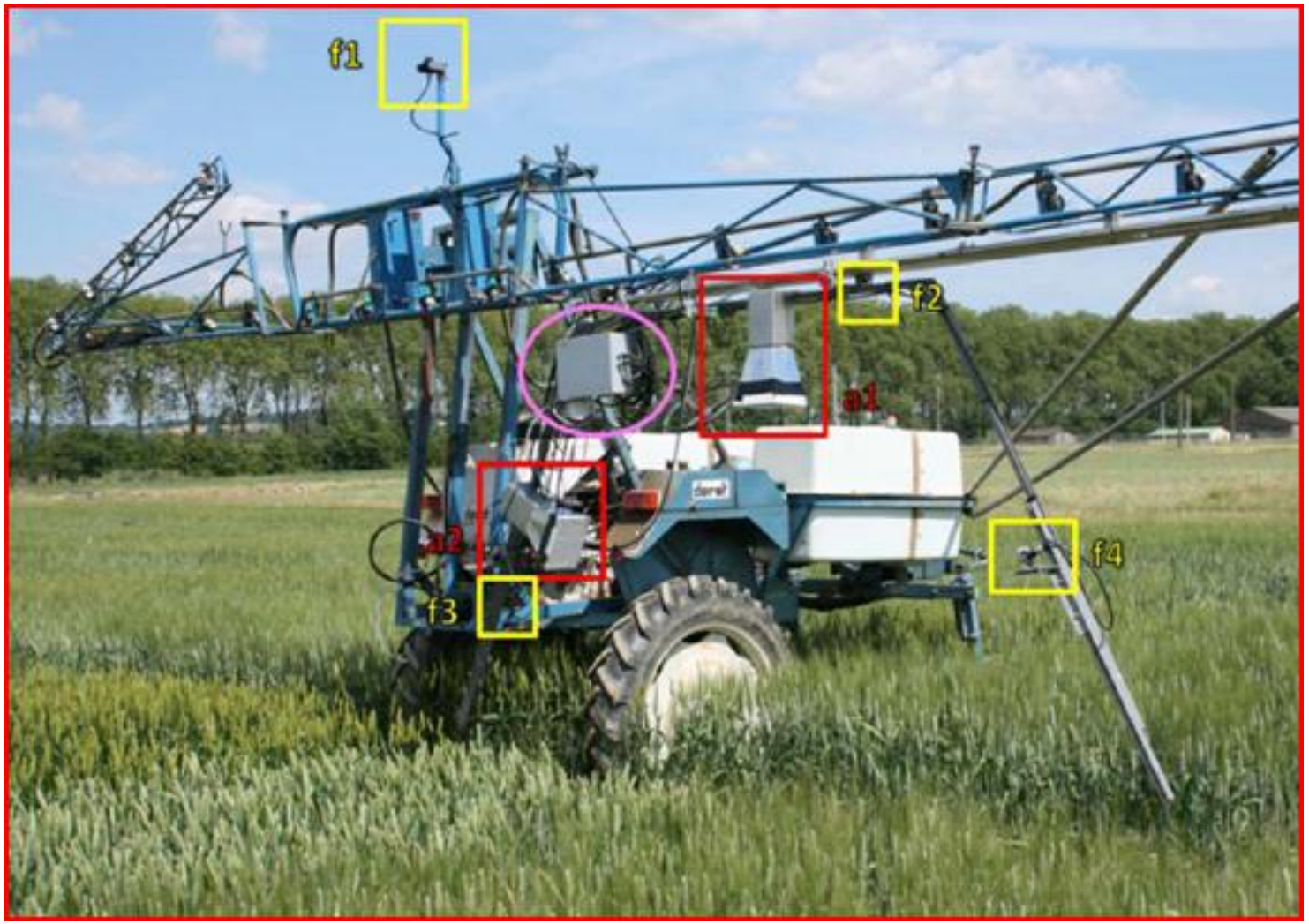


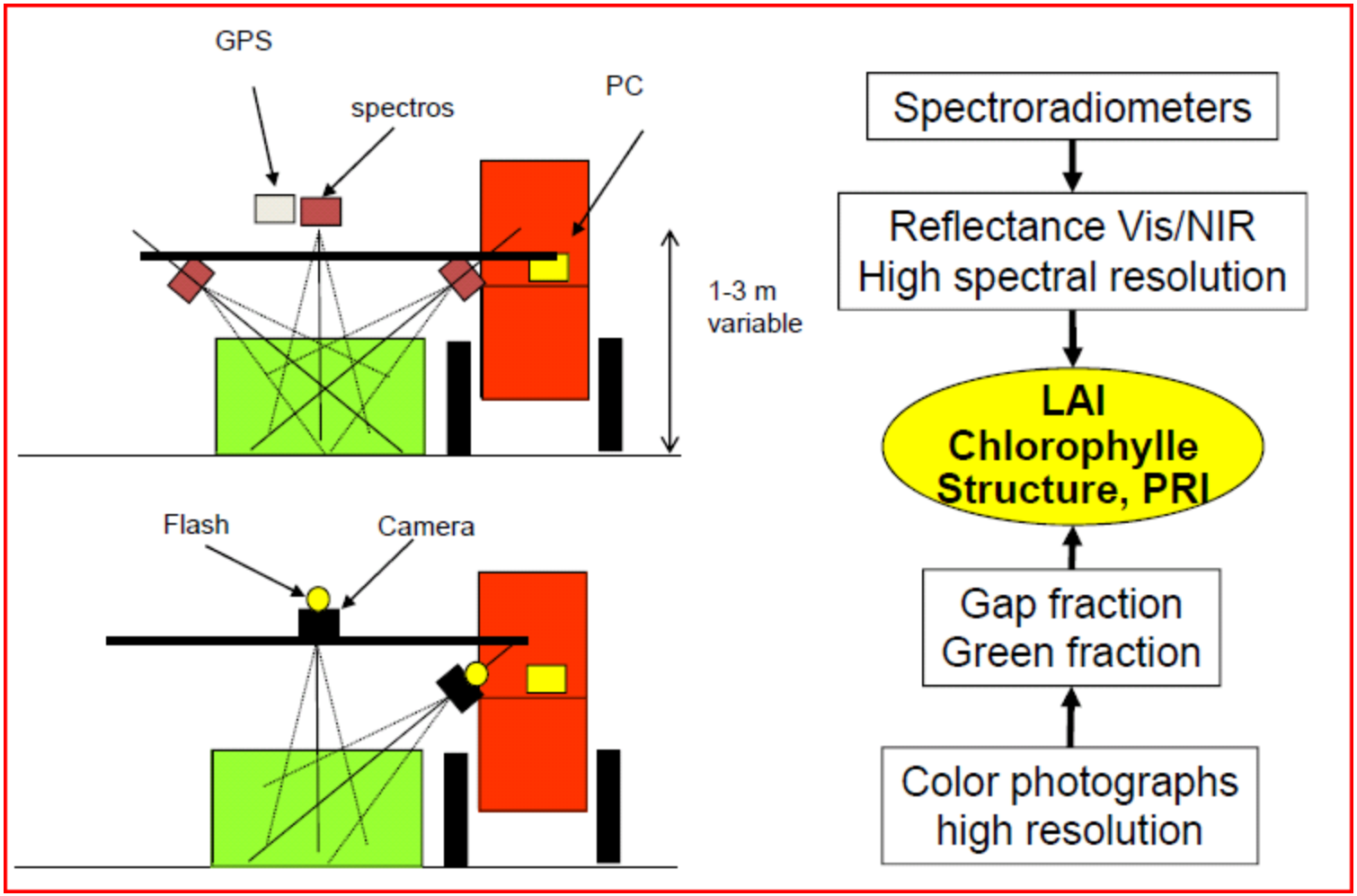
Parameters (BoniRob, maize)

Number of plants, crop density
Spacing in the row
Plant height
Stem thickness
Spectral reflexion
Ground cover, coverage level, ratio crop/soil

Phyllotaxis
Biomass
Growth
Development of single plants/patches

Mobile systems: INRA

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spectros
PC
1-3 m
variable
Flash
Camera
Spectroradiometers
Reflectance Vis/NIR
High spectral resolution
LAI
Chlorophylle
Structure, PRI
Gap fraction
Green fraction
Color photographs
high resolution


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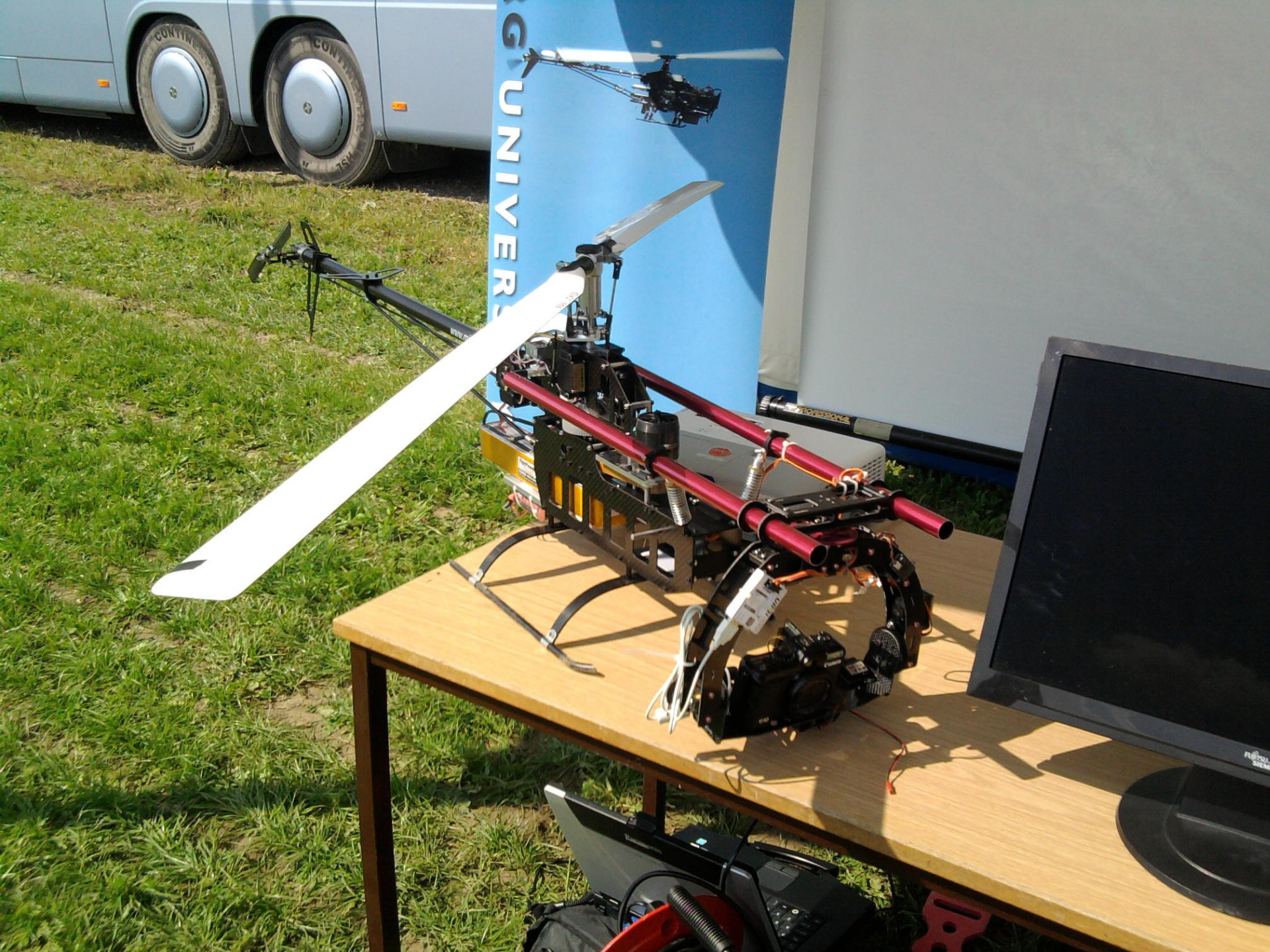
PowerBox Systems


UNIVERS

High throughput field phenotyping

	Field		Glasshouse
	mobile	static	
Control of environment	**-**	**+/-**	**+**
Array of measurements	**-**	**+/-**	**+**
Scale	**+**	**+/-**	**-**
Realism	**+**	**+/-**	**-**
Mobility	+	**-**	**-**

‘White paper’ on Plant Phenotyping

F. Tardieu, U. Schurr

“EPSO workshop on Plant Phenotyping“, Jülich, November 2009

Key Messages

- Plant phenotyping is a bottleneck
- Europe has world-leading groups in plant phenotyping
- Phenotyping is interdisciplinary
- Phenotyping needs to integrate activities in sensorics, environmental simulation, mechanistic, high-throughput and field-based platforms
- Next steps: European Plant Phenotyping Initiative (EPPI)

Some detail

Field phenotyping platforms able to follow growth, gas exchange and status of canopies with large number of plants and genotypes, by using proxy detection (imaging or vegetation indices) with sensors placed on tractors, robots or flying platforms.

Sources of information

JPPC - the Jülich Plant Phenotyping Centre

http://www.fz-juelich.de/icg/icg-3/jppc/

International Plant Phenomics Network
http://www.plantphenomics.com/

What next for UK crops?

1) Catch-up

European Plant Phenotyping Initiative (EPPI)
http://www.plantphenomics.com/phenotyping2009

2) Multi-disciplinary grant application

Physiology
Engineering
Statistics / bioinformatics
Plant breeding and genetics