PRIFYSGOL ABERYSTWYTH UNIVERSITY

Genetic variation in oat grain quality parameters

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- Background
- Panicle variation in quality characteristics
  - TGW
  - KC
- Grain shape analysis
- Conclusions
- Further work

Milling quality

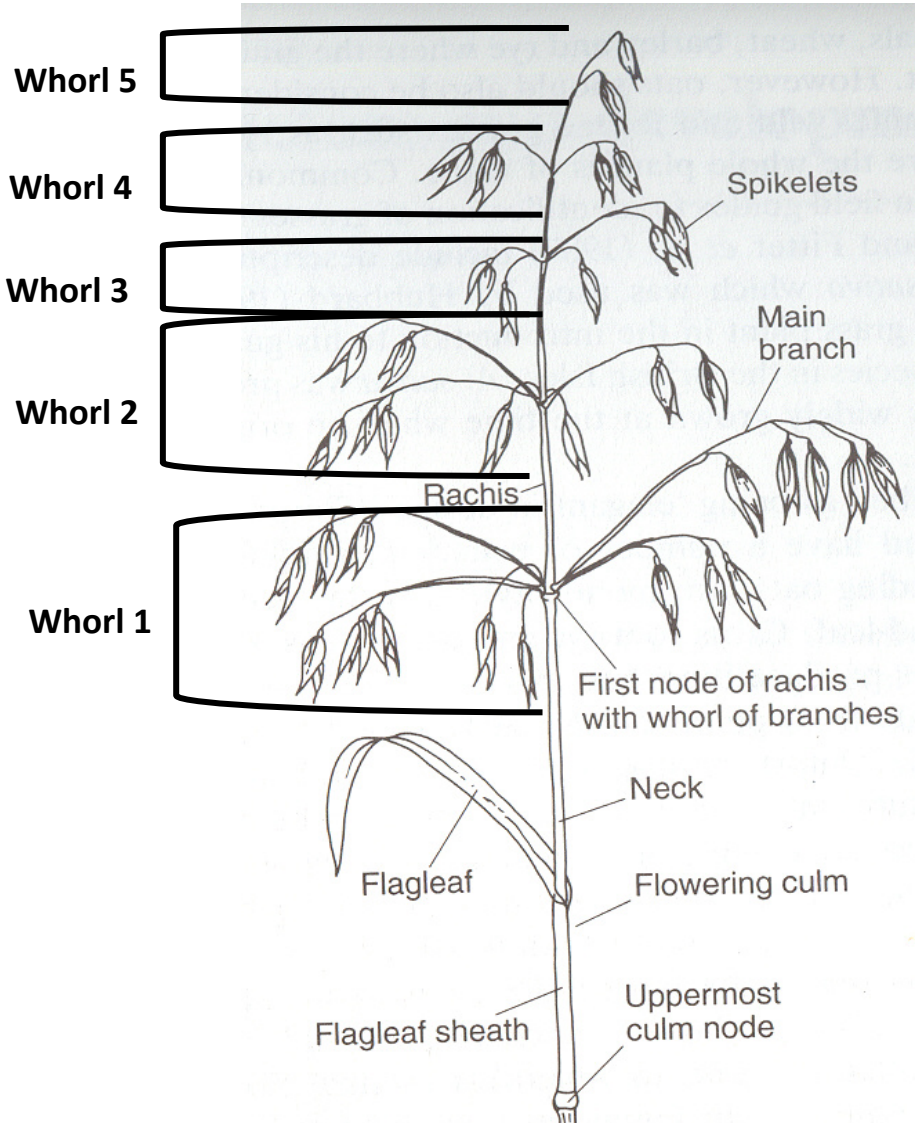
- Specific weight
  - Measure of density/packing
- Kernel content
  - Percentage groat in relation to whole grain
- Hullability
  - The ease with which the husk is removed
- Thousand grain weight

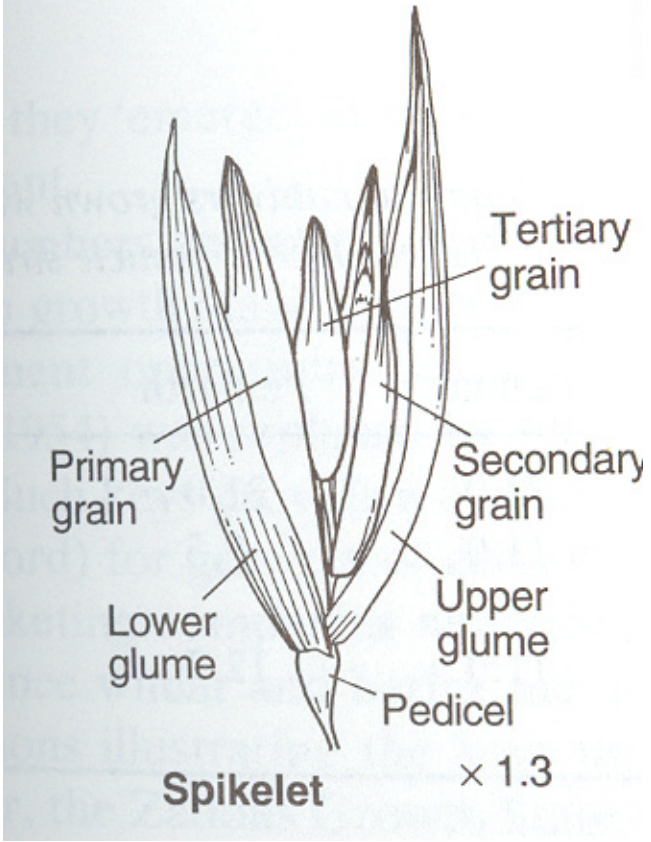
Replicated trial conducted over two years at Aberystwyth

Cultivar name	Year of cross	Years recommended	Yield (t/Ha) while recommended*
Solva	1976	1988 – 1998	6.9 – 7.3
Gerald	1981	1993 – present	6.8 – 8.1
Millennium	1987	2000 – 2006	7.5 – 8.1
Kingfisher	1989	1999 – 2003	7.5 – 7.7
Buffalo	1993	2003 – 2005	8.0 – 8.1
Penderi	1994	-	-
Mascani	1995	2004 – present	7.8 – 8.2
Brochan	1996	2007 – present	8.3 – 8.3
Tardis	1996	2007 – present	8.5 – 8.6
Balado	1998	2010	9.0
01-148Cn4	2001		-
01-150Cn1	2001		-

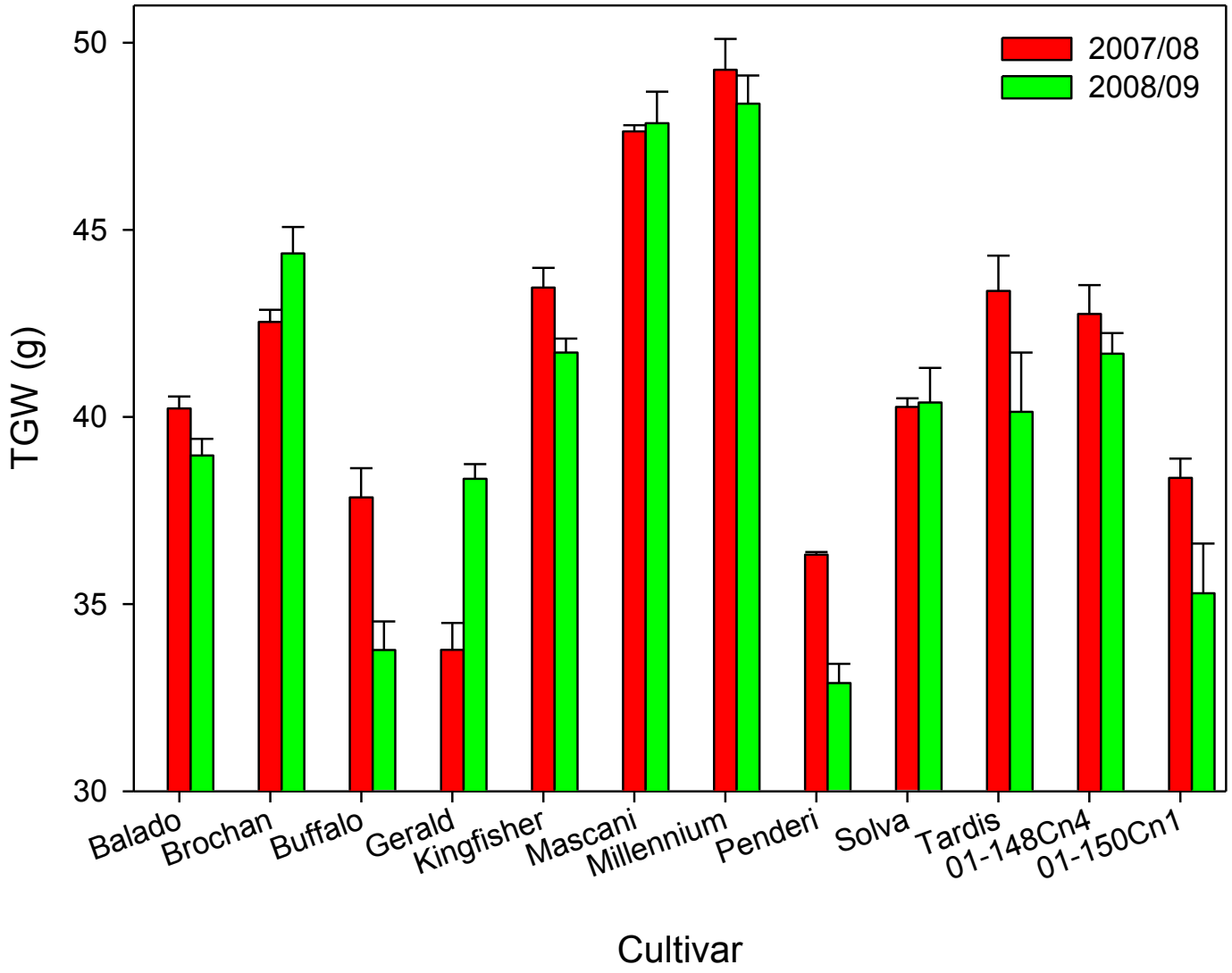
* in official HGCA yield trials

Panicle Structure

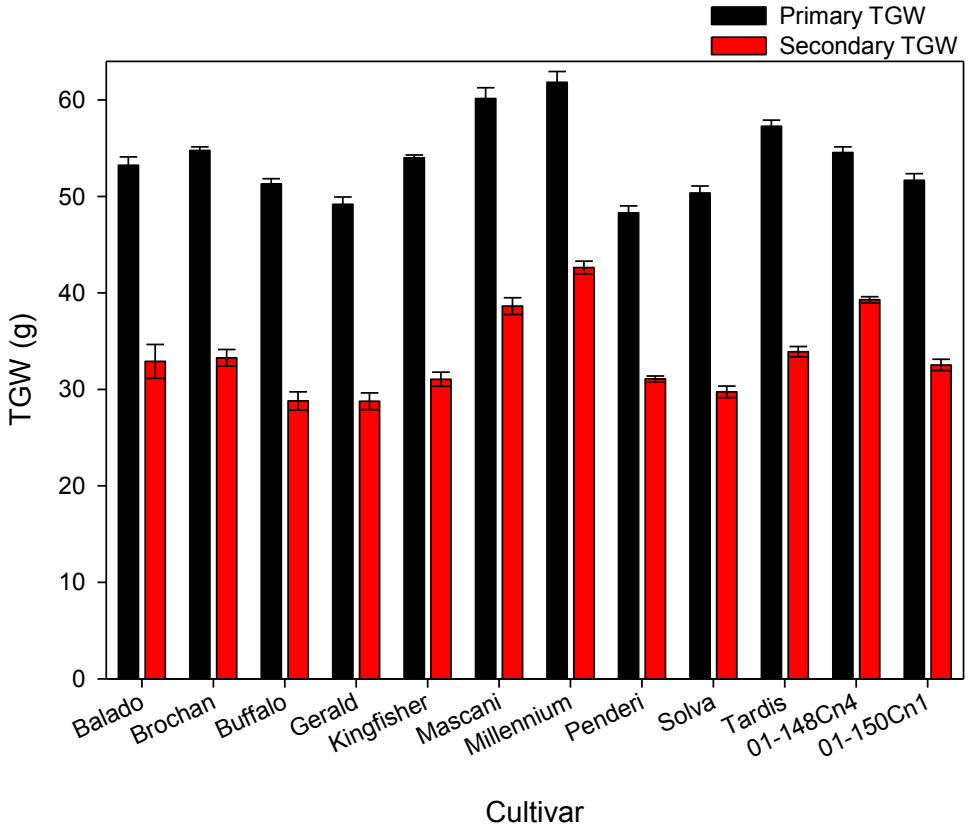


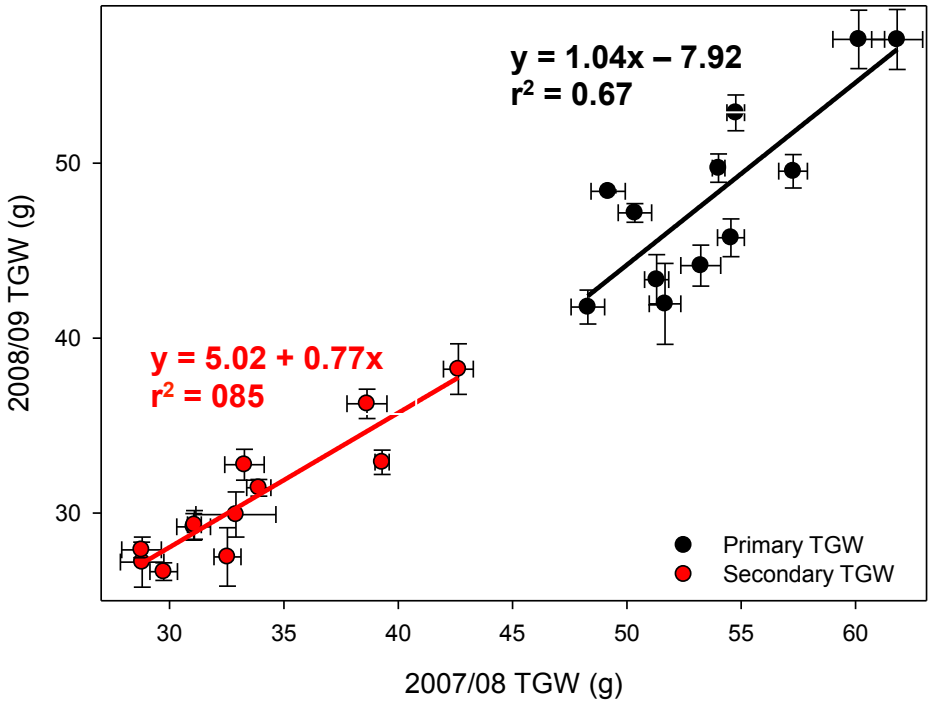


TGW


2007/08
2008/09
TGW (g)
50
45
40
35
30
Balado
Brochan
Buffalo
Gerald
Kingfisher
Mascani
Millennium
Penderi
Solva
Tardis
01-148Cn4
01-150Cn1
Cultivar

Separated TGW





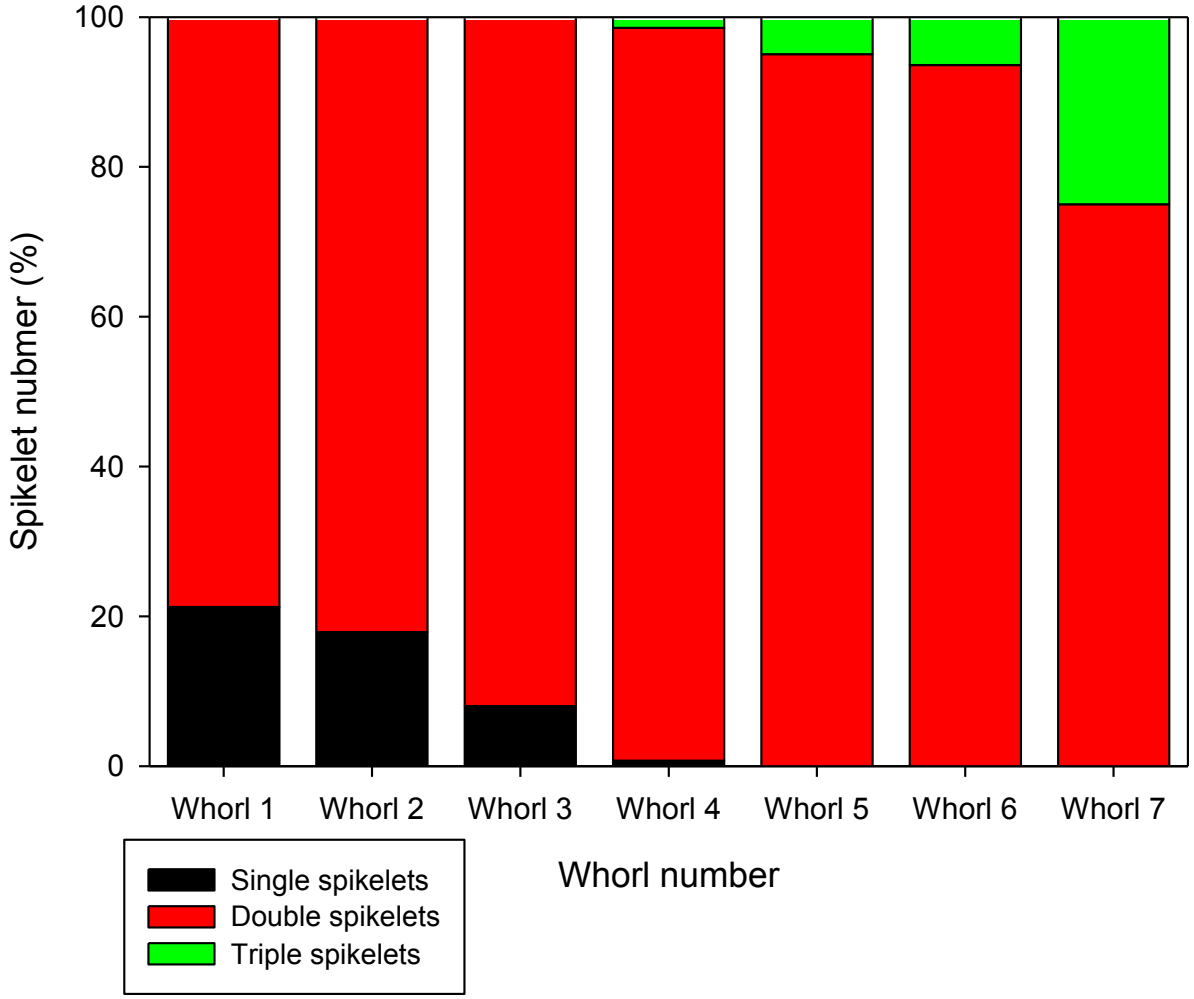
Tardis Panicle TGW

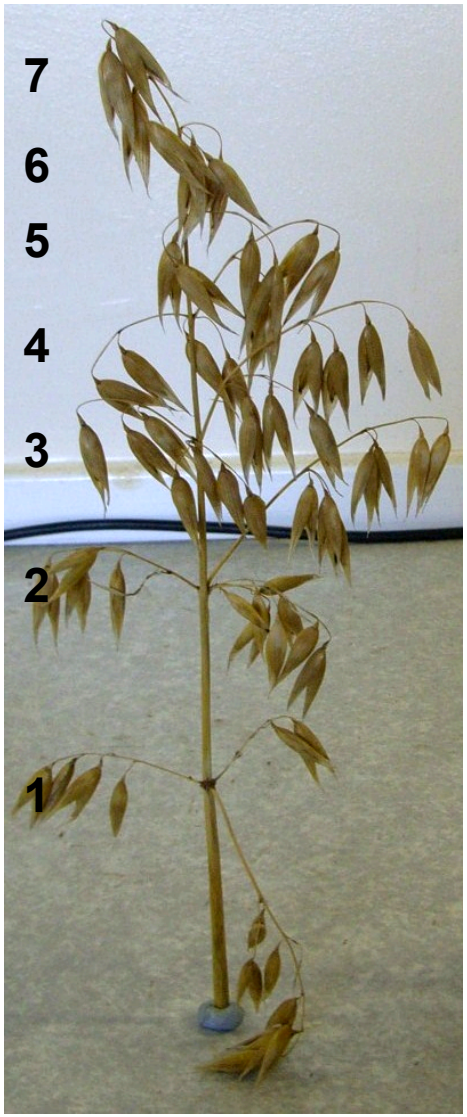
41.6g

Whorl	Total	1°	2°	3°
6	49.2g	76.3g	48.0g	18.9g
5	45.2g	62.8g	45.7g	19.1g
4	44.2g	61.3g	43.9g	17.9g
3	42.5g	58.4g	37.9g	12.9g
2	39.8g	53.9g	28.4g	13.7g
1	37.3g	51.5g	24.7g	19.7g

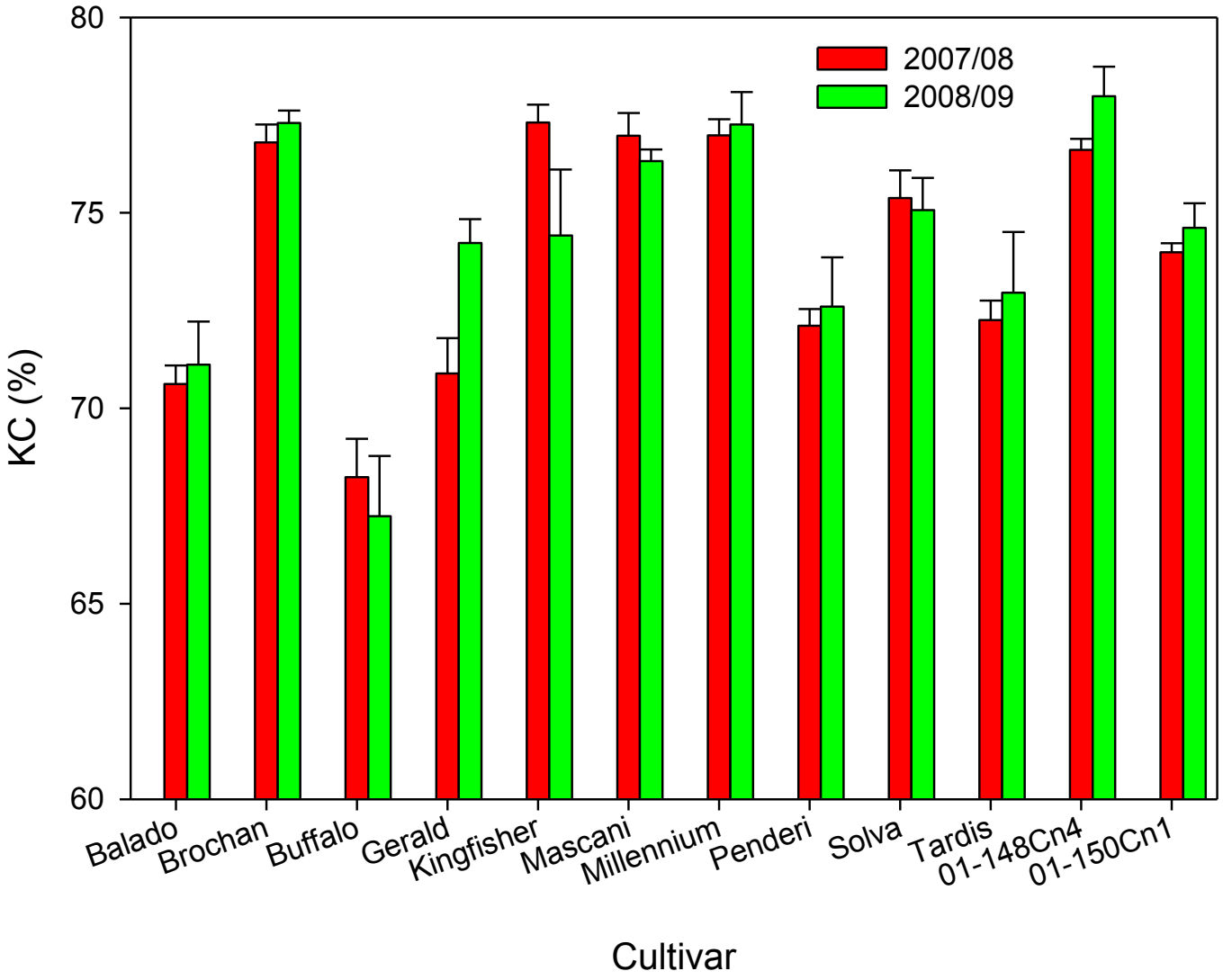
Grain proportions per whorl

Brochan in 2007/08

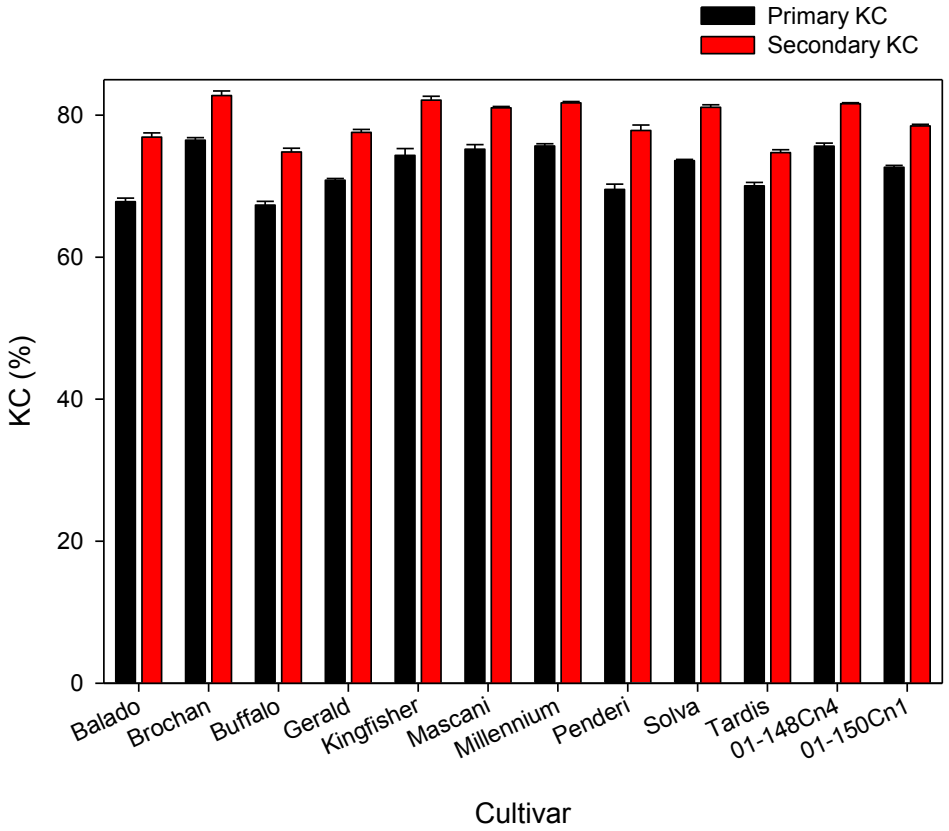


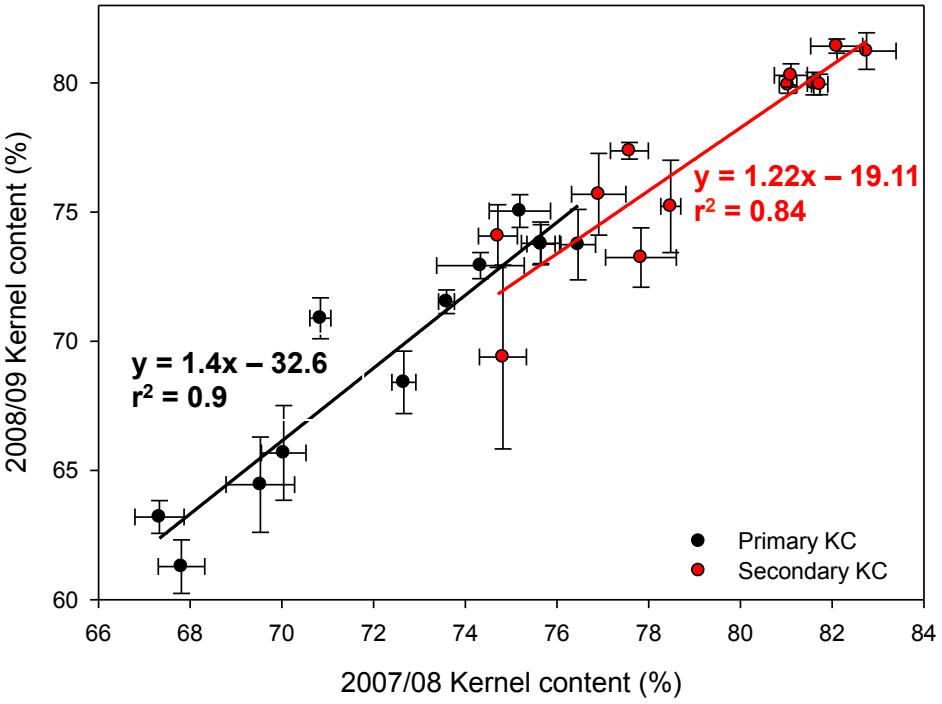


Kernel content



Separated kernel content

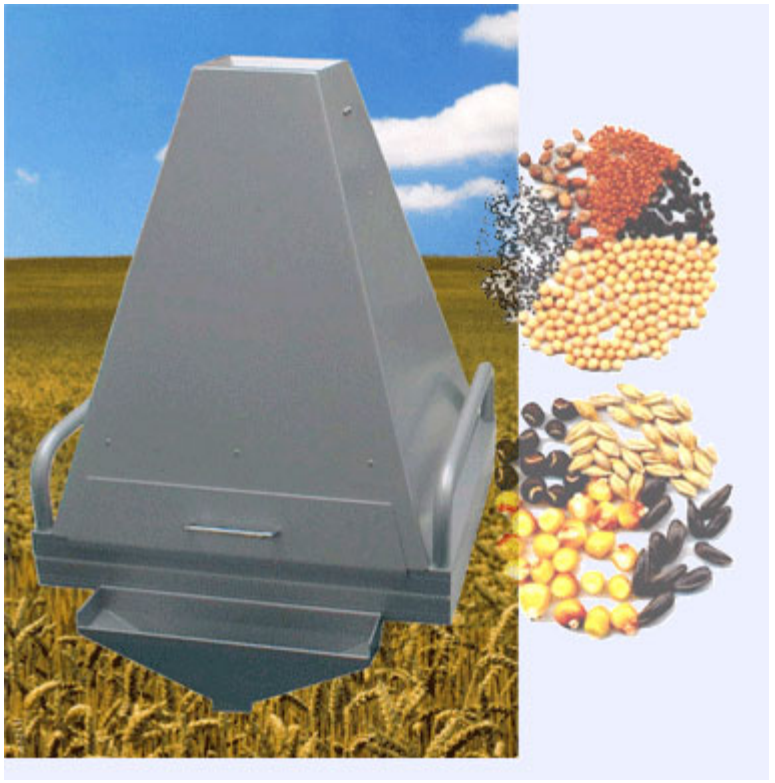


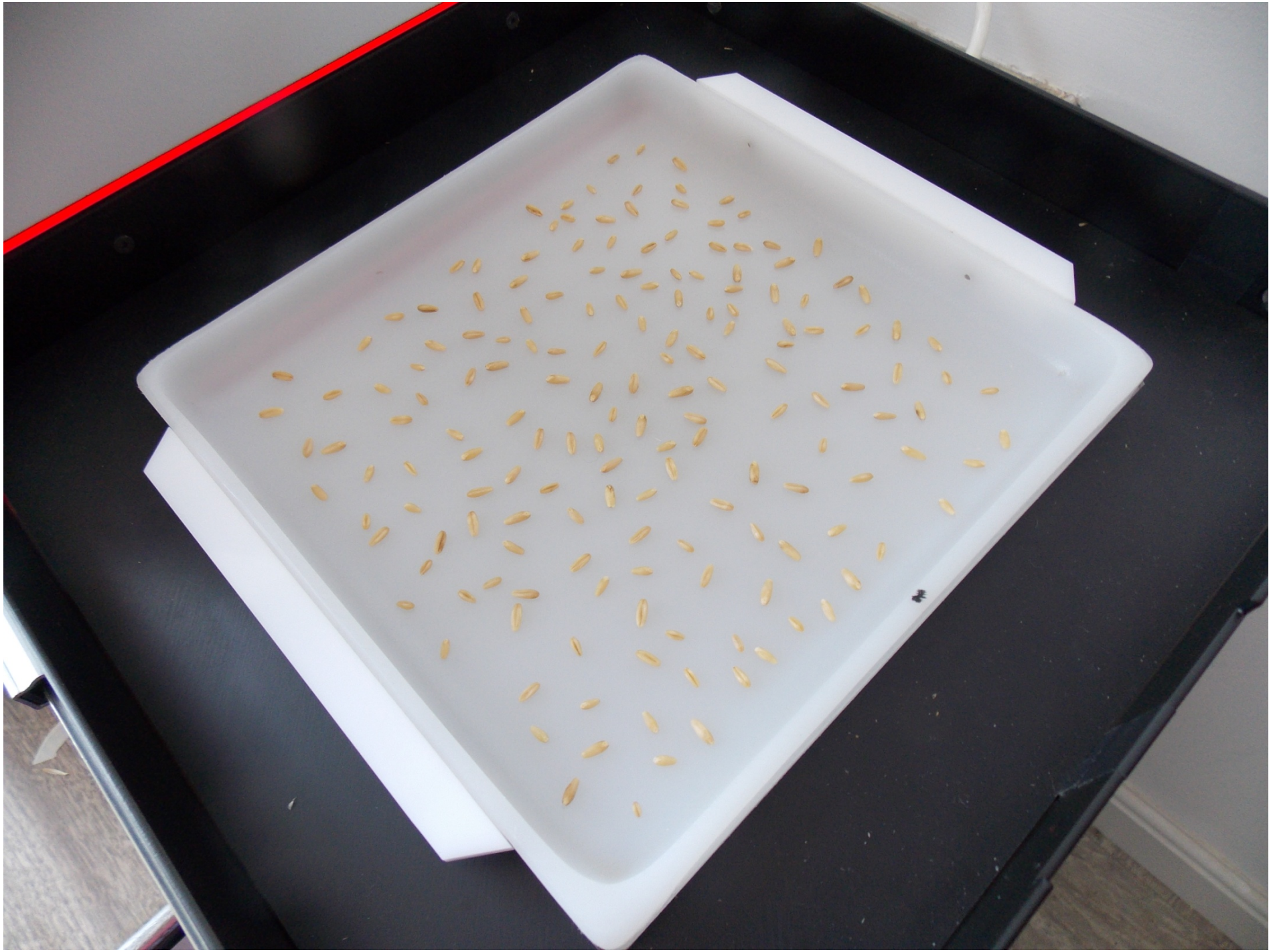


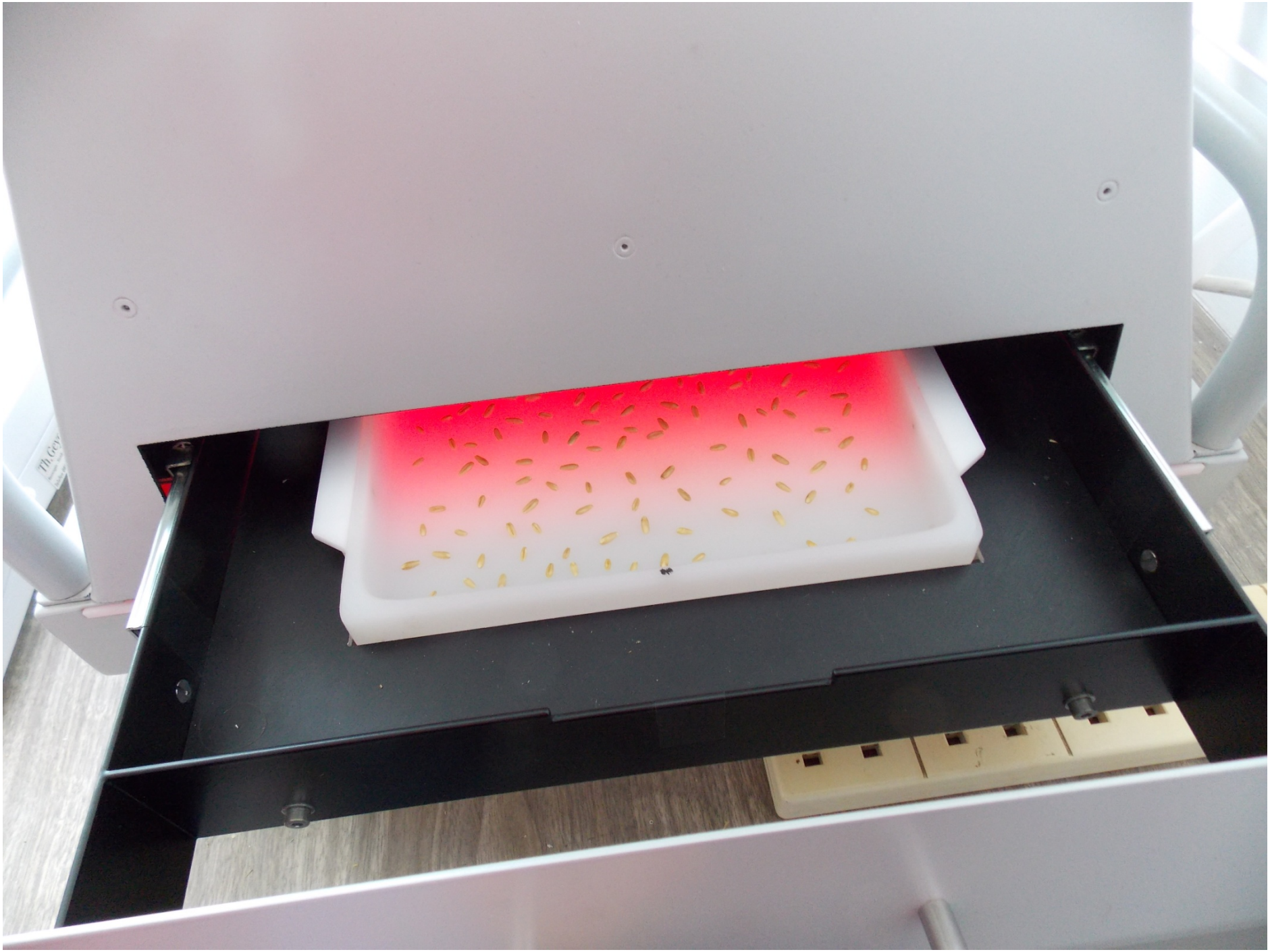
- **Kernel content was conducted on a bulk grain sample for each cultivar and also on a separated sample of primary and secondary grain**
- **The kernel content of the secondary grain was always higher than that of the primary grain**
- **High correlation in kernel content obtained between seasons**

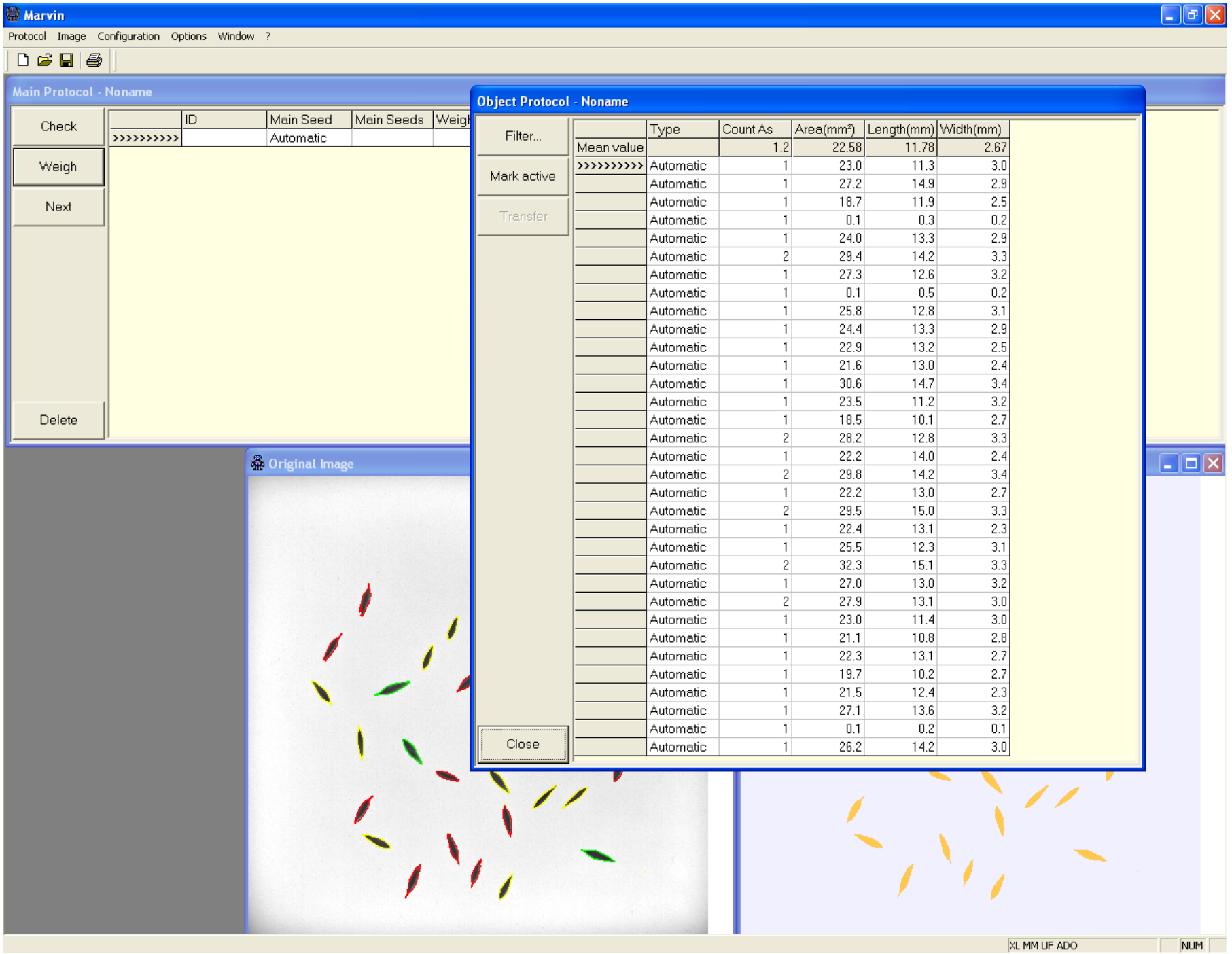
Method development

- **MARVIN**
  - **Grain analyser**
  - **Measures the length, width and area of individual grain**







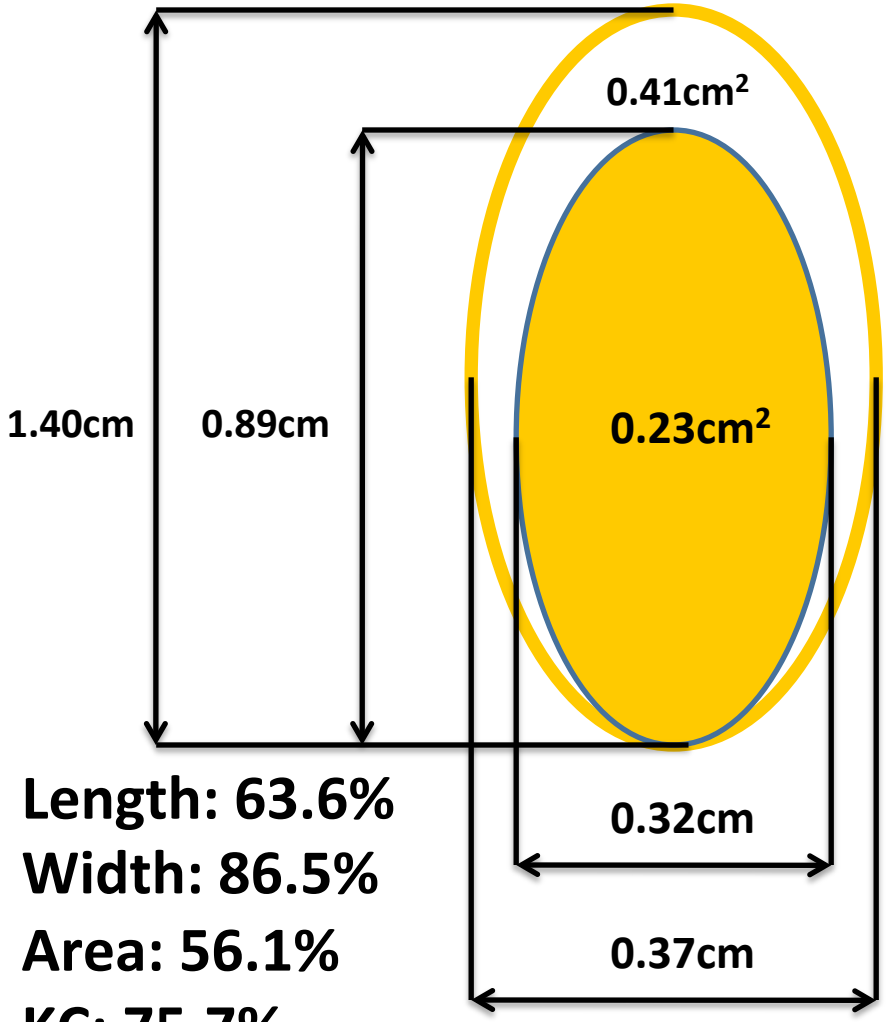

Marvin
Protocol Image Configuration Options Window ?
Main Protocol - Noname
Check
Weigh
Next
Delete
ID
Main Seed
Main Seeds
Automatic
Object Protocol - Noname
Filter...
Mark active
Transfer
Close
Type
Count As
Area(mm²)
Length(mm)
Width(mm)
Mean value 1.2 22.58 11.78 2.67
Automatic 1 23.0 11.3 3.0
Automatic 1 27.2 14.9 2.9
Automatic 1 18.7 11.9 2.5
Automatic 1 0.1 0.3 0.2
Automatic 1 24.0 13.3 2.9
Automatic 2 29.4 14.2 3.3
Automatic 1 27.3 12.6 3.2
Automatic 1 0.1 0.5 0.2
Automatic 1 25.8 12.8 3.1
Automatic 1 24.4 13.3 2.9
Automatic 1 22.9 13.2 2.5
Automatic 1 21.6 13.0 2.4
Automatic 1 30.6 14.7 3.4
Automatic 1 23.5 11.2 3.2
Automatic 1 18.5 10.1 2.7
Automatic 2 28.2 12.8 3.3
Automatic 1 22.2 14.0 2.4
Automatic 2 29.8 14.2 3.4
Automatic 1 22.2 13.0 2.7
Automatic 2 29.5 15.0 3.3
Automatic 1 22.4 13.1 2.3
Automatic 1 25.5 12.3 3.1
Automatic 2 32.3 15.1 3.3
Automatic 1 27.0 13.0 3.2
Automatic 2 27.9 13.1 3.0
Automatic 1 23.0 11.4 3.0
Automatic 1 21.1 10.8 2.8
Automatic 1 22.3 13.1 2.7
Automatic 1 19.7 10.2 2.7
Automatic 1 21.5 12.4 2.3
Automatic 1 27.1 13.6 3.2
Automatic 1 0.1 0.2 0.1
Automatic 1 26.2 14.2 3.0
Original Image
XL MM UF ADO
NUM

Shape data

- **Length, cm**
- **Width, cm**
- **Ratio (width/length) – an estimate of roundness**
- **Area, cm^2 (πab) – of ellipse**
- **Perimeter, cm ($\pi[\ 3(a+b) - \sqrt{(3a+b)(a+3b)}]$)**

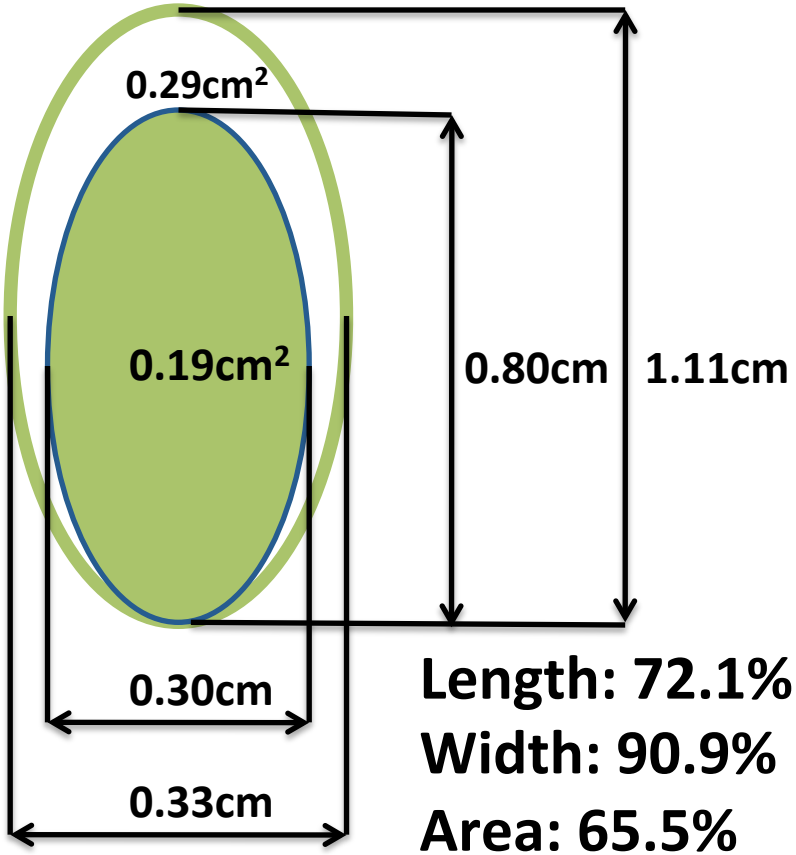
Comparison of grain and groat dimensions

Millennium primary grain



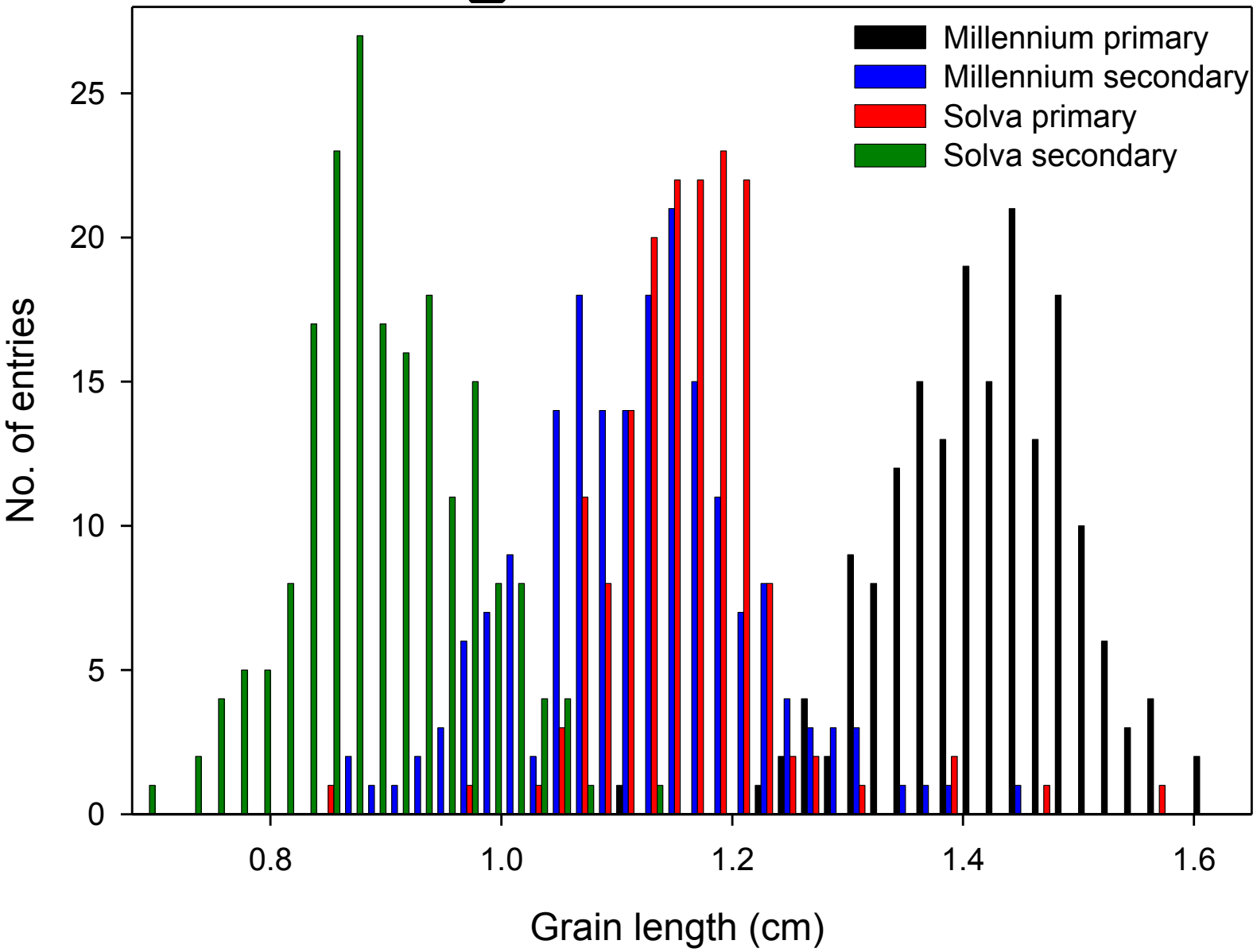
Length: 63.6%
Width: 86.5%
Area: 56.1%
KC: 75.7%

Millennium secondary grain

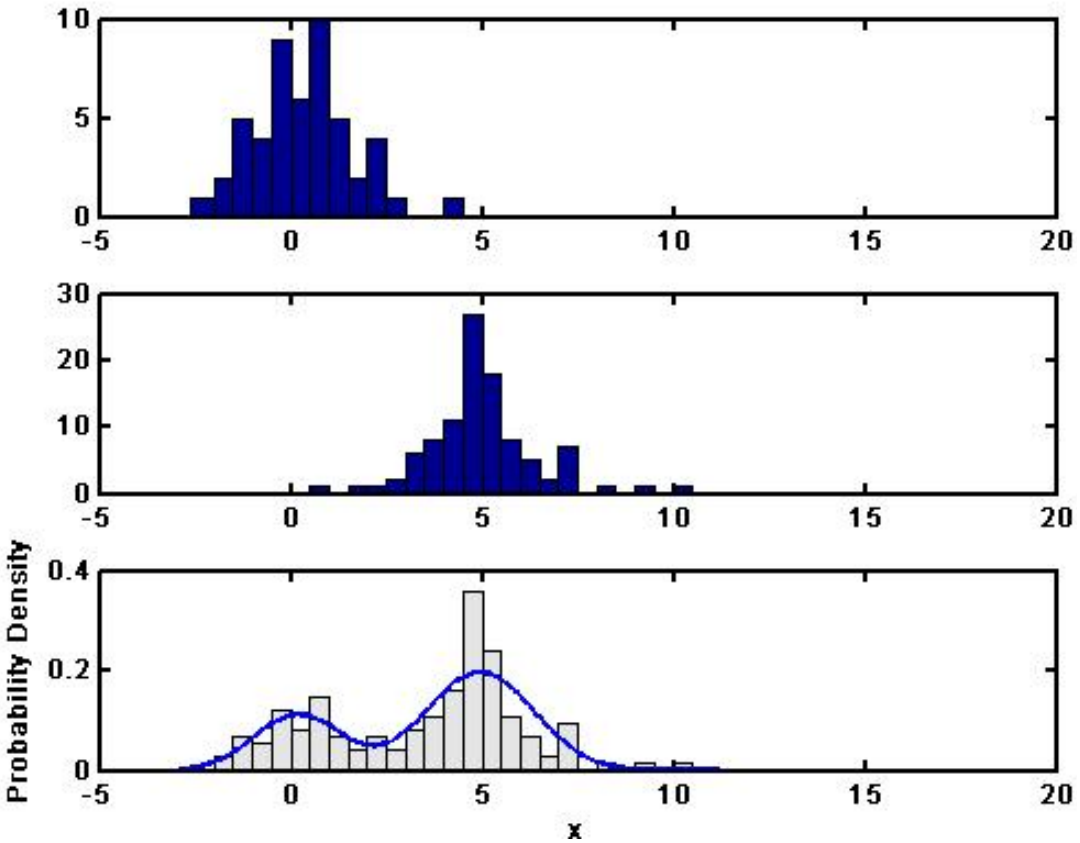


Length: 72.1%
Width: 90.9%
Area: 65.5%
KC: 81.7%

Grain length: Two cultivars



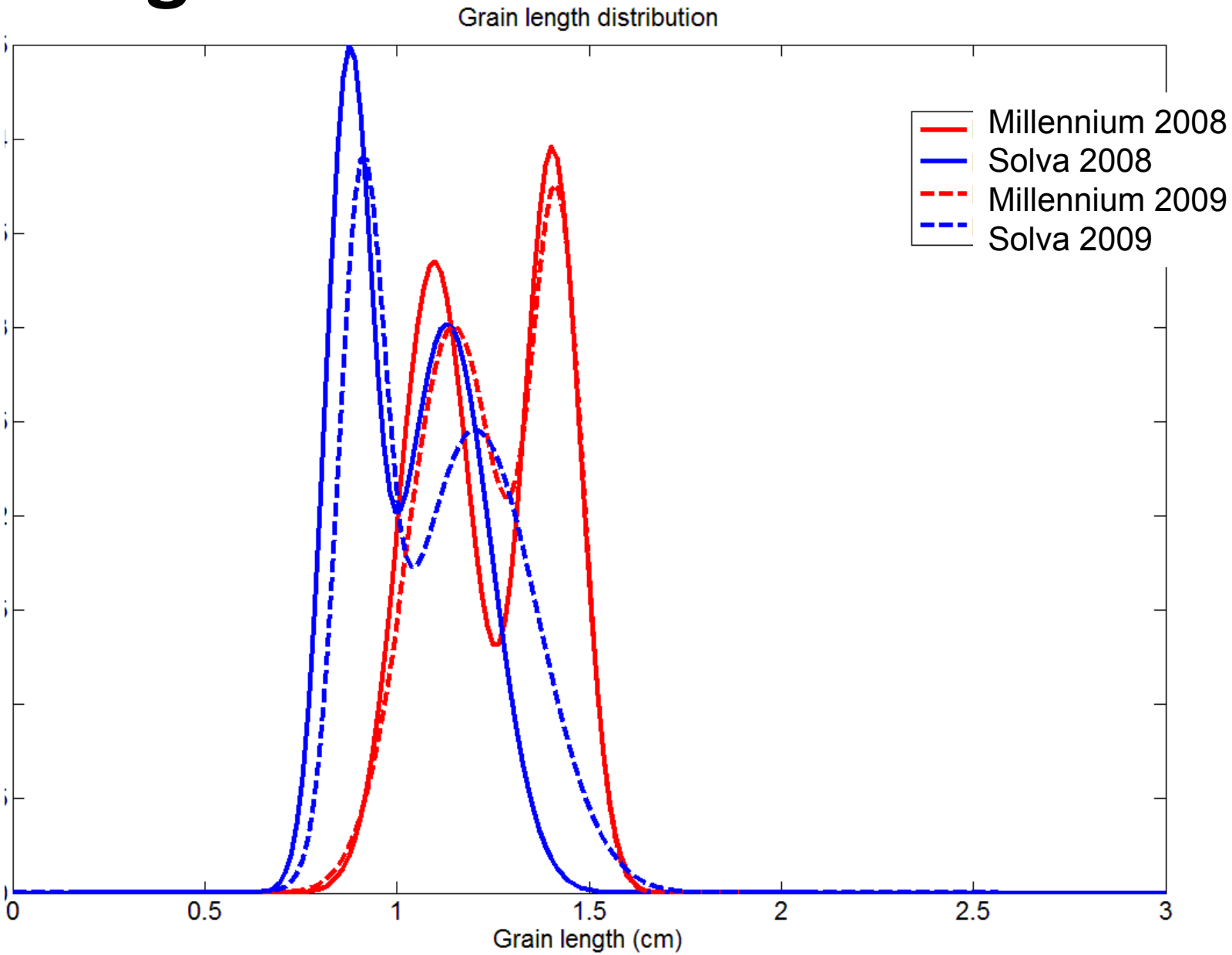
Fitting two normal distributions



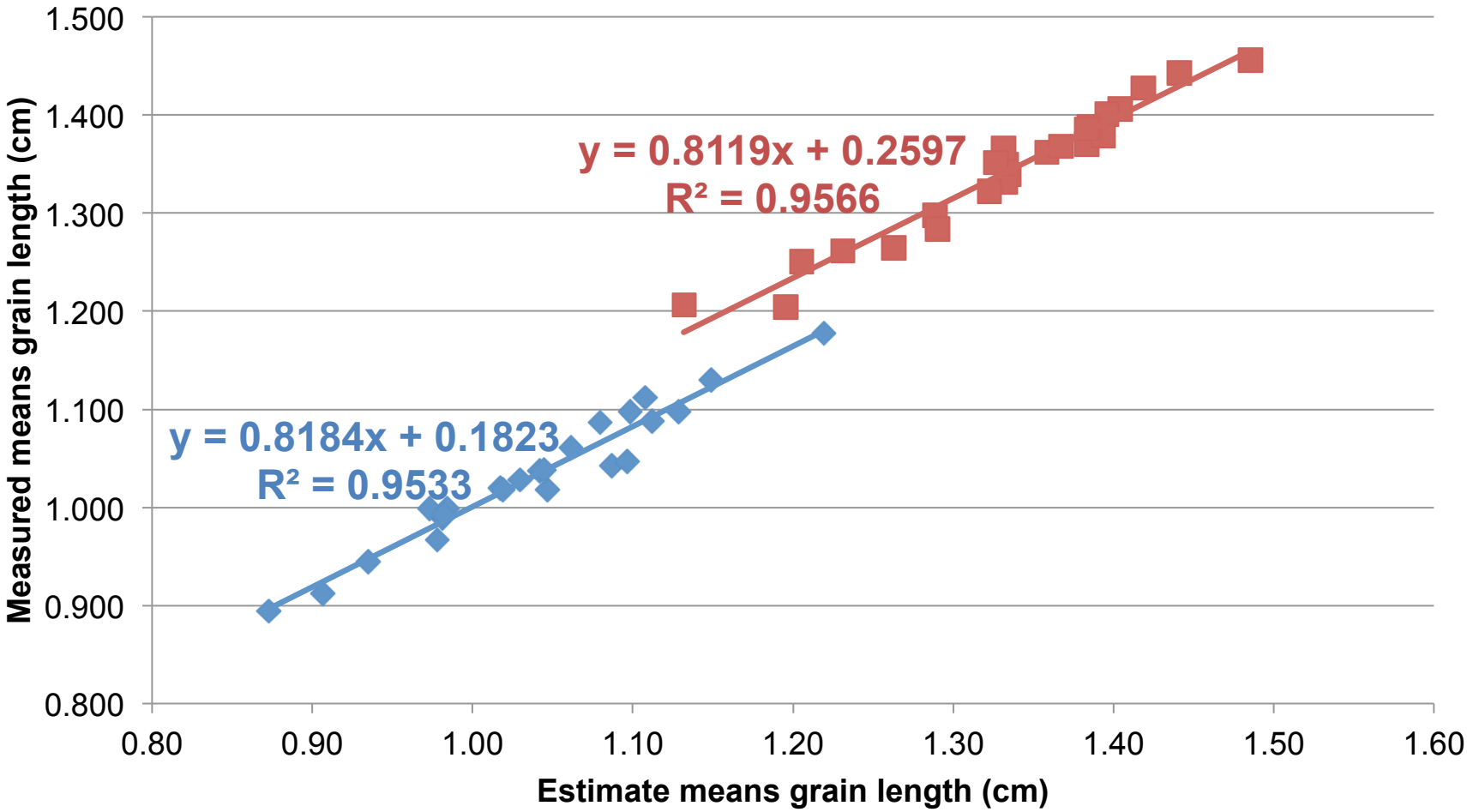
Parameters

Mean 1, mean 2
Standard deviation 1, standard deviation 2
Proportion in each distribution, p and 1-p

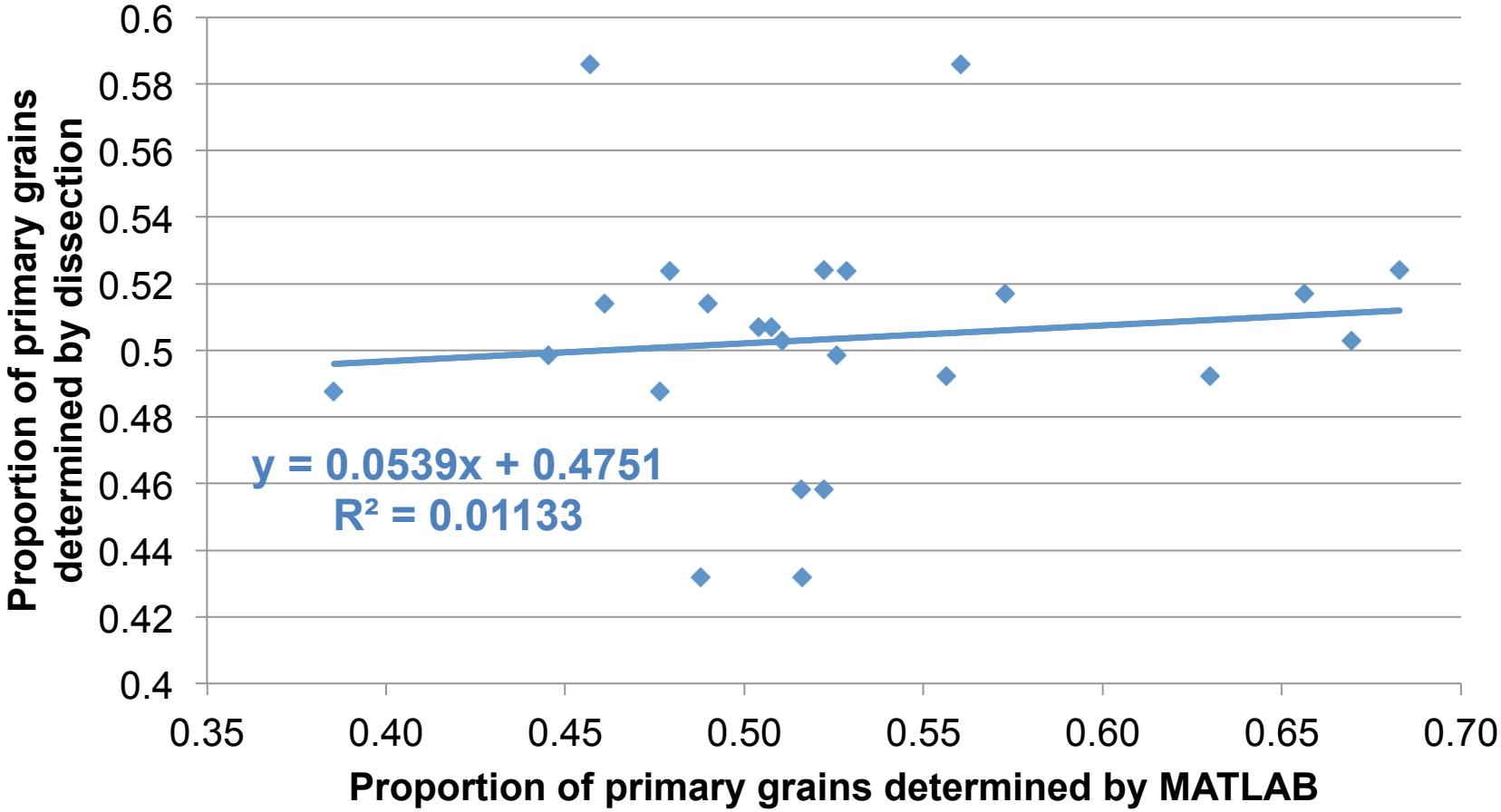
Fitting the two normal distribution



Correlation 1



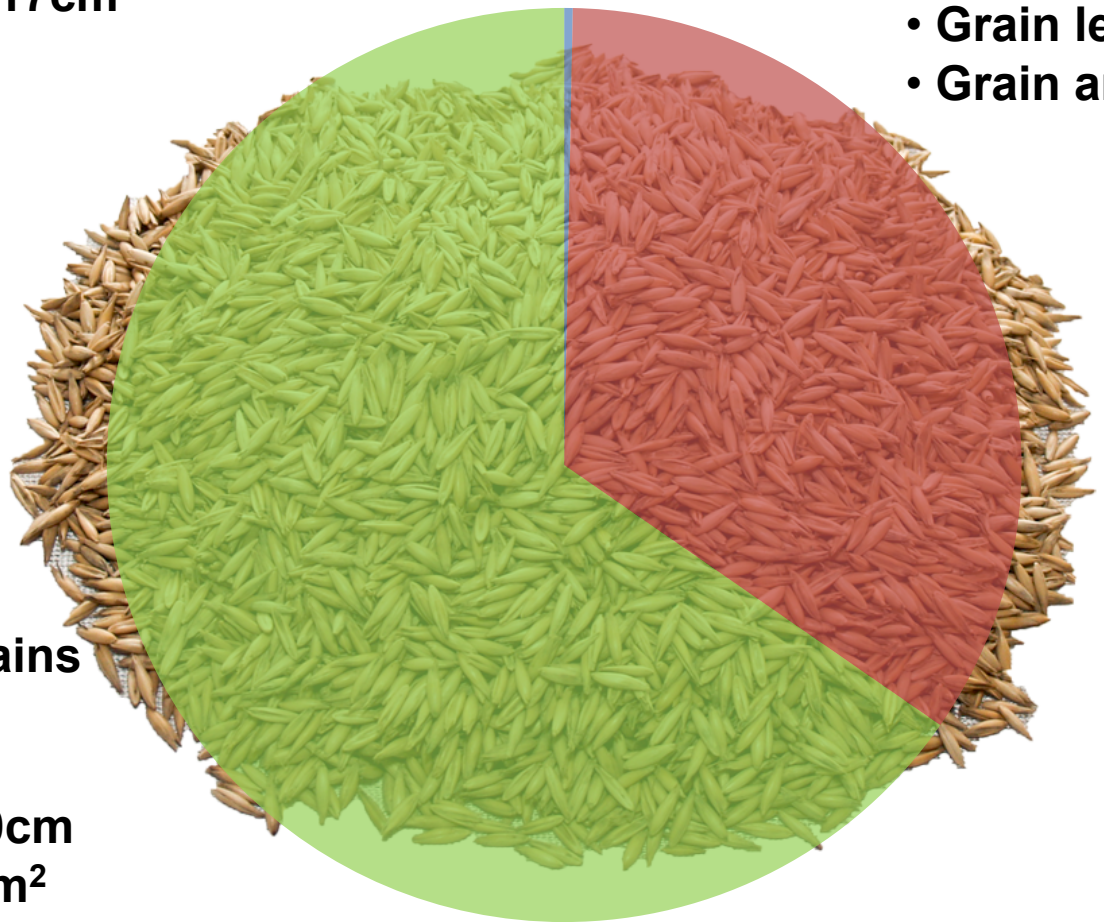
Correlation 2



In a tonne of Gerald

3 kg tertiary grains
- **TGW 20g**
- **Grain length 0.61cm**
- **Grain area 0.17cm^2**

343 kg secondary grains
- **TGW 28g**
- **KC 77%**
- **Grain length 0.95cm**
- **Grain area 0.24cm^2**

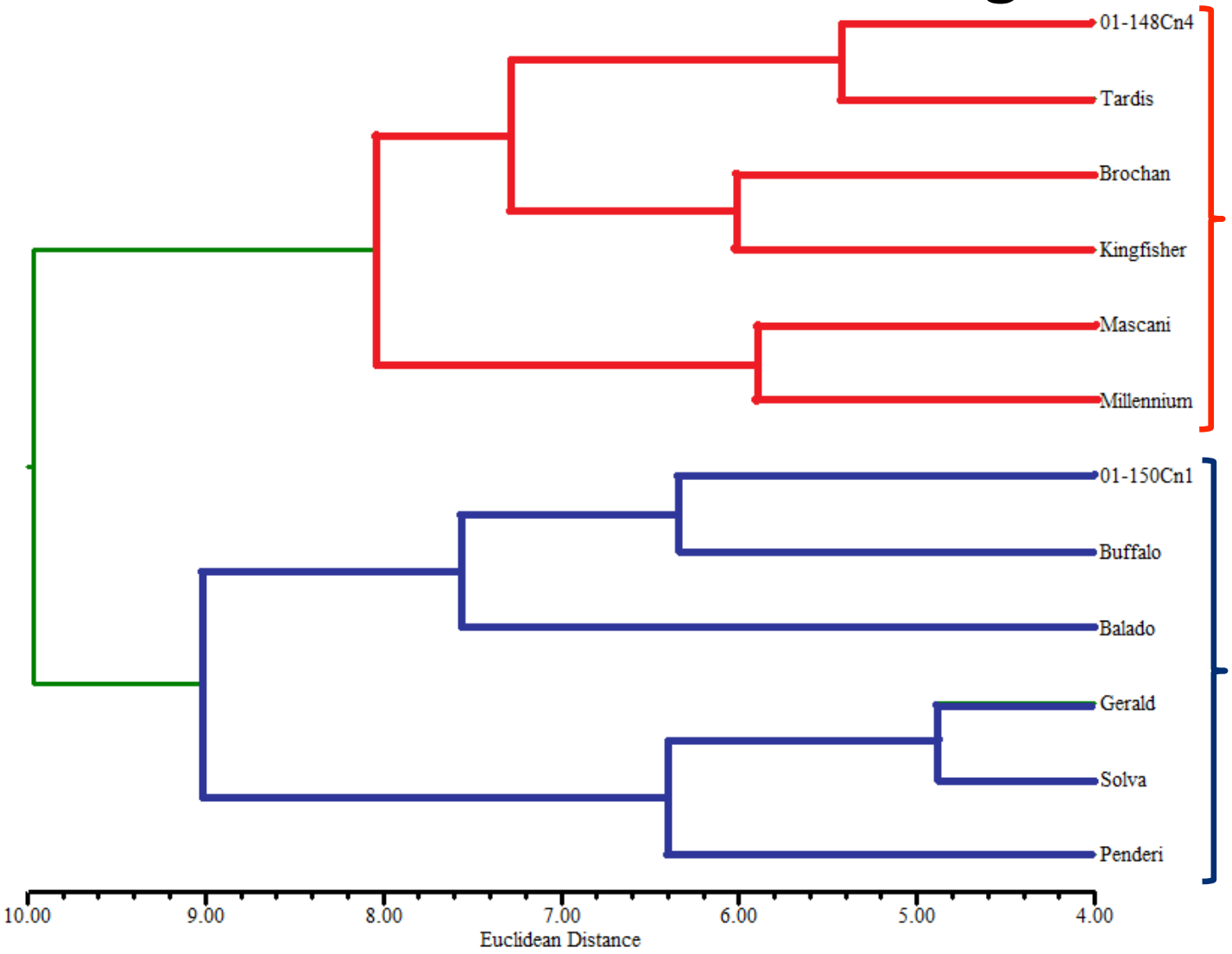


653 kg primary grains
- **TGW 49g**
- **KC 70%**
- **Grain length 1.20cm**
- **Grain area 0.34cm^2**

Characteristics of primary, secondary and tertiary grain of 12 cultivars

	Proportion (kg tonne^{-1})			TGW (g)			Grain length (cm)		
	1°	2°	3°	1°	2°	3°	1°	2°	3°
Solva	645	354	1	50	30	22	1.21	0.90	0.89
Gerald	653	343	3	49	29	21	1.20	0.95	0.61
Millennium	589	396	14	62	43	21	1.41	1.10	0.81
Kingfisher	711	289	1	54	31	23	1.30	1.00	0.82
Buffalo	644	350	6	51	29	23	1.30	0.99	0.90
Penderi	606	384	11	48	31	18	1.26	1.00	0.71
Mascani	610	375	14	60	39	23	1.32	1.04	0.72
Brochan	648	349	3	55	33	13	1.33	1.02	0.98
Tardis	595	344	61	57	34	18	1.40	1.11	0.76
Balado	630	368	2	53	33	34	1.34	1.02	0.81
01-148Cn4	559	402	39	55	39	19	1.36	1.09	0.76
01-150Cn1	613	382	5	52	33	18	1.36	0.99	0.70

Dendrogram displaying similarities between cultivars based on 42 grain traits



Early flowering time, high KC and TGW, long grains, low grain numbers

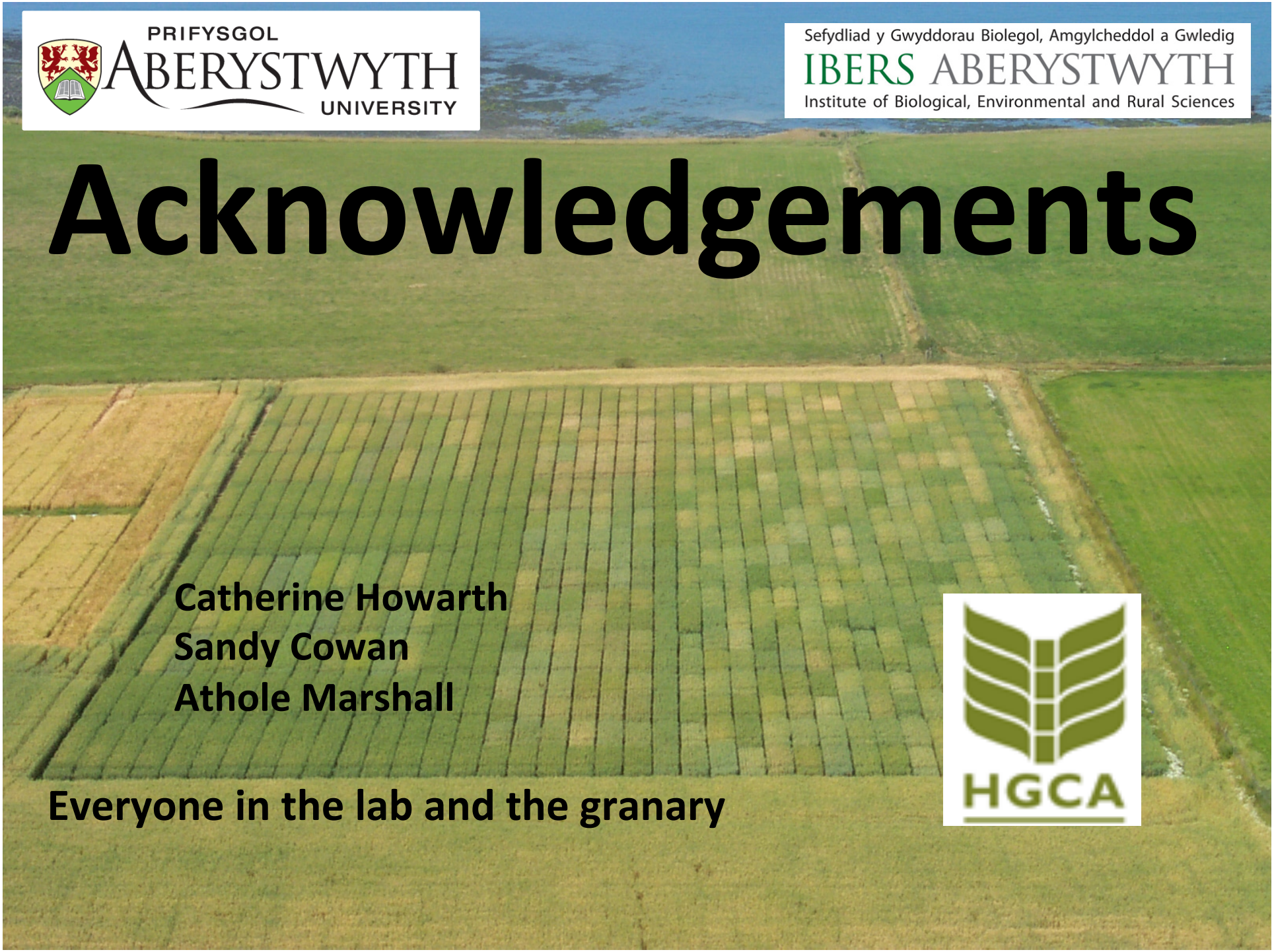
Late flowering time, low KC and TGW, short grains, high grain numbers

Conclusions

- Winter oats used in the study could be divided into two groups based on grain traits, panicle structure and flowering traits
- Variation across the panicle for TGW is large
- Grain shape analysis showed the bi-modal distribution of oat grains, MATLAB analysis allows characterization of harvest samples and greater understanding of grain lots

Further work

- Understand the grain size of new varieties
- Investigate links between grain size, panicle variation and mill performance
- Investigate methods of high throughput grain measurements
- Identify lines with more uniform grain size for higher mill performance



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Acknowledgements

Catherine Howarth
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Everyone in the lab and the granary

HGCA

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