UKCPVS 2009 ANNUAL REPORT

MILDEW OF BARLEY

A J HUBBARD, V FANSTONE and R A BAYLES

NIAB, Huntingdon Road, Cambridge CB3 0LE, UK.

Virulence was common for most of the resistances in current UK barley cultivars. Exceptions were virulence for *Mla3*, virulence for *Mla13* and virulence for an unidentified resistance in cultivars NFC Tipple and Propino. The frequency of these remained below 40% in the population. No virulence was detected for *mlo*, which remains an effective source of resistance and continues to be widely deployed in spring barley cultivars.

INTRODUCTION

There was a low to moderate incidence of barley mildew in 2009.

METHODS

A total of 111 single pustule isolates of barley mildew were tested in 2009. These comprised 67 isolates from infected cultivars in field plots and 44 isolates from seedling trap nurseries of the universally susceptible barley cultivar Golden Promise.

Table 1 shows the cultivars from which isolates were tested. There were more isolates from winter cultivars (37) than from spring cultivars (26). The majority of isolates came from susceptible cultivars with resistance ratings of 5 or below, but 21 isolates were from moderately resistant cultivars with ratings of 6 or 7 and 6 isolates were from cultivars with high resistance ratings of 8. There were no isolates from the most highly resistant varieties with ratings of 9.

The locations from which cultivar isolates originated are shown in Table 2. Isolates came either from East Anglia or from the extreme west of the UK (South-West England, Wales and Northern Ireland). There were no samples from the north of England or Scotland.

Seedling trap nurseries were exposed at 5 locations within a 30mile radius of Cambridge.

The differential and additional cultivars used in seedling tests are listed in Table 3.

Table 1. Cultivars from which isolates were tested

Cultivar	Winter / Spring	1-9 resistance rating*	No. of isolates tested
Flagon	Winter	7	2
Malabar	Winter	7	2
Bronx	Winter	7	1
Carat	Winter	7	1
Pelican	Winter	7	1
Suzuka	Winter	6	3
Pearl	Winter	6	2
Sequel	Winter	6	2
Winsome	Winter	6	2
Retriever	Winter	6	1
Volume	Winter	5	1
Wintmalt	Winter	5	1
Cassata	Winter	4	7
Purdey	Winter	4	5
Saffron	Winter	3	6
Centurion	Spring	8	2
NFC Tipple	Spring	8	2
Propino	Spring	8	2
Oxbridge	Spring	7	2
Cocktail	Spring	6	2
Forensic	Spring	5	9
Optic	Spring	5	6
Bigo	Spring	?	1
Unknown	?	?	4
TOTAL			**67**

*HGCA resistance ratings for 2010/11, or most recent available.

Table 2. Locations from which cultivar isolates originated

Region	County	No. of isolates tested
East Anglia	Cambridgeshire	7
	Norfolk	13
South West	Devon	4
Wales	Monmouthshire	20
Ireland	Co. Down	17
	Co. Londonderry	6
TOTAL		**67**

RESULTS AND DISCUSSION

Table 3 shows virulence frequencies estimated from seedling tests.

As in 2007, virulence for many of the resistance genes found in UK barley cultivars remained at very high levels. These included *Mlh, Mlra, Mlg, MlCP, MlLa, Mla12, Mla7, Ml(Ab)* and *Mla1*.

At the same time, there were indications of substantial increases in virulence for *Mla6* and for the 'Van' resistance, also thought to be present in Oxbridge. The increase in virulence for *Mla6* continues the trend noted in 2007 and may well be a reflection of the presence of this resistance in several popular winter barley cultivars, including Boost, Saffron and Sequel.

Virulences for *Mlk* and *Mla13* (also in Cocktail) remained at intermediate frequencies.

Low levels of virulence were detected as in previous years for *Mla3* and for *Mla9.*

The spring barley cultivars NFC Tipple and Propino, both with high resistance ratings of 8, were added to the differential set for 2009 because mildew samples had been received from them. Virulence for both cultivars was detected at moderate levels and was not restricted to isolates derived from the host cultivar. This indicates that corresponding virulence is moderately common amongst isolates from non-selective host cultivars. There was evidence from the pattern of cultivar x isolate interactions that the two cultivars carry the same resistance, which differs from any of the other resistances in the differential set.

No virulence was detected for *mlo* and this resistance continues to provide a large proportion of UK spring barley cultivars with effective protection against mildew.

Table 3. Virulence frequencies (%) from 1998 to 2009

Differential cultivar	Resistance factor	98	99	00	01	02	03	04	05	07	**09**
Core set											
W 37/136	*Mlh*	61	58	50	68	83	92	97	99	92	**96**
W 41/145	*Mlra*	100	100	100	100	100	100	100	96	80	**76**
Goldfoil	*Mlg*	97	97	97	99	99	100	93	96	98	**99**
Zephyr	*Mlg,Ml(CP)*	94	95	96	98	97	99	91	94	79	**95**
Midas	*Mla6*	31	26	23	19	20	9	13	22	44	**77**
Lofa	*MlLa*	72	89	88	95	92	97	91	98	92	**95**
Hassan	*Mla12*	76	87	88	99	99	98	93	93	84	**97**
Hordeum 1063	*Mlk1*	73	66	61	57	52	35	25	43	35	**26**
Porter	*Mla7*	76	85	95	99	96	96	90	96	73	**74**
Lotta	*Ml(Ab)*	53	71	79	95	95	95	89	85	81	**74**
Triumph	*Mla7,(Ml(Ab))*									73	**74**
Tyra	*Mla1*	45	64	65	67	73	80	79	81	66	**61**
Roland	*Mla9*	32	25	29	28	15	11	5	15	8	**10**
Digger	*Mla13*	25	19	11	17	13	9	9	22	38	**29**
Ricardo	*Mla3*	1	1	5	1	2	5	1	8	11	**19**
Apex	*mlo*									0	**0**
Riviera	*mlo*									0	**0**
Additional cultivars											
Vanessa	*'Van'*					20	14	24	40	28	**90**
Cocktail	*Mla13+?*					0	?	5	19	21	**26**
Doyen	*Mla3?*						0	1	8	20	**50**
Oxbridge	*?'Van'*										**68**
Optic	*Mla12, Ml(Ab)*										**76**
NFC Tipple	*?*										**35**
Propino	*?*										**34**
No. of isolates		743	629	689	235	339	413	407	134	85	**111**

UKCPVS 2009 ANNUAL REPORT

YELLOW RUST OF WHEAT

A J HUBBARD and R A BAYLES

NIAB, Huntingdon Road, Cambridge CB3 0LE, UK.

Most isolates tested in 2009 were of the pathotype WYV 1,2,3,4,6,9,17,32, with virulence for cultivars Robigus and Solstice. This widely virulent pathotype was detected for the first time in 2008 and is capable of infecting at least half of the UK's currently Recommended wheat varieties.

INTRODUCTION

There was a high incidence of yellow rust in wheat in 2009, mainly in the highly susceptible cultivar Oakley.

2009 ISOLATES: SEEDLING VIRULENCE TESTS

METHODS

Over 100 samples of yellow rust were received by the UKCPVS and from these 42 isolates were selected for testing on the basis of source cultivar and location.

Isolates were tested from 20 different cultivars (Table 1), the most common being the popular susceptible cultivar Oakley, which occupied around 14% of the UK wheat area in 2009. 23 isolates came from susceptible varieties (ratings 2-5), 12 from moderately resistant varieties (ratings 6-8) and 7 from resistant varieties (rating = 9).

Most isolates came from the high risk eastern counties of England.

Virulence tests were carried out on seedlings of the differential cultivars listed in Table 3, using the methods described by Priestley, Bayles and Thomas, 1984. Additional cultivars, of particular relevance to UK breeding, were added to the core differential set.

Table 1. Cultivars from which wheat yellow rust isolates were tested

Cultivar	1-9 Resistance rating*	No. of isolates tested
Oakley	2	7
Ketchum	4	4
Viscount	4	4
Solstice	4	2
Gallant	4	1
Einstein	5	2
Duxford	5	2
Marksman	5	1
QPlus	6	4
JB Diego	6	2
Battalion	6	1
Kingdom	6	1
Humber	8	3
Timber	8	1
Panorama	9	2
Alchemy	9	1
Beluga	9	1
Claire	9	1
Warrior	9	1
Zebedee	9	1
TOTAL		**42**

*HGCA resistance ratings for 2010/11.

Table 2. Locations from which wheat yellow rust isolates were tested

Region	County	No. of isolates tested
East Anglia	Cambridgeshire	11
	Norfolk	1
East Midlands	Lincolnshire	19
West Midlands	Shropshire	1
	Herefordshire	1
Yorkshire	East Yorkshire	7
South East	Essex	1
	Kent	1
TOTAL		**42**

Table 3. Differential cultivars used in 2009 seedling virulence tests

Differential cultivar	WYR factor	Gene designation
Core set		
Chinese 166	WYR1	*Yr1*
Kalyansona	WYR2	*Yr2*
Vilmorin 23	WYR3	*Yr3+*
Nord Desprez	WYR3	*Yr3+*
Hybrid 46	WYR4	*Yr4*
Heines Kolben	WYR2,6	*Yr2, Yr6*
Heines Peko	WYR2,6	*Yr2, Yr6*
Lee	WYR7	*Yr7*
Brock	WYR7	*Yr7*
Compair	WYR8	*Yr8*
Kavkaz x 4 Fed	WYR9	*Yr9*
Clement	WYR9	*Yr9*
AVS xYr15	WYR15	*Yr15*
VPM 1	WYR17	*Yr17*
Rendezvous	WYR17	*Yr17*
Carstens V	WYR32	*Yr32*
Talon	WYR32	*Yr32*
Additional cultivars*		
Robigus	WYR'Rob'	
Cadenza	R	
Madrigal	WYR6,9,17	
Hornet	WYR6,9	
Alchemy (9)		
Claire (9)		
Panorama (9)		
Zebedee (9)		
Humber (8)		
Timber (8)		
Battalion (6)	WYR17+	
Cordiale (6)	WYR7	
JB Diego (6)		
KWS Horizon (6)		
QPlus (6)		
Duxford (5)		
Marksman (5)	WYR17+	
Gallant (4)		
Ketchum (4)		
Solstice (4)		
Viscount (4)		
Oakley (2)		

* with resistance ratings in brackets for cultivars on current HGCA RL

RESULTS and DISCUSSION

Virulence frequency data for 2009, together with data from 1999-2008, are shown in Table 4.

Table 4. Virulence frequencies (%) from 1999 to 2009

Virulence for		99	00	01	02	03	04	05	06	07	08	**09**
WYR 1		99	100	100	97	100	100	100	-	-	100	**100**
WYR 2		99	100	100	97	100	100	100	-	-	100	**100**
WYR 3		100	100	100	97	100	93	100	-	-	91	**99**
WYR 4		87	90	74	63	86	50	87	100	100	81	**98**
WYR 6		21	32	39	31	50	42	10	19	4	19	**90**
WYR 7		10	4	0	3	36	4	8	11	4	0	**0**
WYR 8		0	0	0	0	0	0	0	0	0	0	**0**
WYR 9		99	92	90	88	93	100	95	100	94	93	**93**
WYR 15				0	0	0	0	0	0	0	0	**0**
WYR 17		100	96	77	88	93	85	97	100	88	83	**87**
WYR 32		4	16	42	73	64	38	85	89	92	79	**94**
<u>Additional cvs</u>												
Robigus	WYR Rob						31	79	89	84	81	**81**
Cadenza	R			0	0	0	0	0	0	0	0	**0**
Madrigal	WYR 6,9,17							8	11	4	19	**76**
Hornet	WYR 6,9								19	4	19	**81**
Alchemy												**14**
Claire								23	0	4	14	**43**
Panorama												**12**
Zebedee												**24**
Humber										4	10	**67**
Timber									7	0	5	**2**
Battalion	WYR 17+									0	0	**0**
Cordiale	WYR 7											**0**
JB Diego										0	14	**31**
QPlus												**48**
Duxford											0	**12**
Marksman	WYR 17+									0	0	**10**
Gallant											19	**79**
Ketchum												**7**
Solstice											10	**69**
Viscount												**74**
Oakley												**81**
No. of isolates tested		97	50	31	36	14	48	39	27	25	21	**42**

There was a substantial increase in virulence for WYR6 in 2009, bringing it to 90%, compared with its previous 3-year mean of 14%. Virulence for Solstice, first detected in 2008 in 10% of isolates, was confirmed in 69% of 2009 isolates.

There continued to be very high levels of virulence for WYR1, WYR2, WYR3, WYR4, WYR9, WYR17 and for Robigus. No virulence was detected for WYR7, although this virulence has been recorded at low levels in 8 of the past 10 years. There was no virulence for WYR8. This virulence was reported in the UK in 1976 and again in 1977 and 1982, but has not re-emerged since then. Virulence for WYR15 and for Cadenza remained undetected.

Virulence for Timber was confirmed in a single isolate from the cultivar.

Table 5. Pathotype frequencies 2009 (%)

Pathotype	Virulence for Robigus / Solstice	%
WYV 1,2,3,4,6,9,17,32	Rob, Sol	60
WYV 1,2,3,4,6,9,17,32	Rob	17
WYV 1,2,3,4,6,9,17,32	Sol	5
WYV 1,2,3,4,6,9,17		2
WYV 1,2,3,4, 9,17,32	Rob	5
Uncertain	Uncertain	12

The yellow rust population was dominated by the complex pathotype WYV1,2,3,4,6,9,17,32 (Table 5). Although most isolates of this pathotype were virulent on both Robigus and Solstice, a few appeared to be virulent on either Robigus or Solstice. Isolates virulent on Solstice were also virulent on Oakley. However a few isolates (pathotype WYV1,2,3,4,6,9,17) were virulent on Oakley, but not on Solstice.

2008 ISOLATES: ADULT PLANT TESTS

METHODS

Five isolates (Table 5) were tested on a set of 42 cultivars in adult plant tests in field isolation nurseries. Seedling tests of the same isolates and cultivars were carried out under standard controlled environment conditions.

Table 6. Isolates tested on adult plants in 2008.

Code	Year	Location	Cultivar	Virulence at seedling stage
08/7	2008	Cambs	Claire	1,2,3,4,6,9,17,Cla
08/21	2008	Cambs	Solstice	1,2,3,4,6,9,17,32,Rob,Sol
08/30	2008	E Yorks	Gallant	1,2,3,4,9,17,32,Rob
08/38	2008	Cambs	Solstice	1,2,3,4,6,9,17,32,Rob,Sol
08/501	2008	Cambs	Timber	1,2,3,4,6,9,17,Tim

*Cla = Claire; Rob = Robigus; Sol = Solstice; Tim = Timber

RESULTS AND DISCUSSION

The results of adult plant tests are presented in Table 7. Percentage leaf area infected is expressed as the mean of nine assessments made at regular intervals between 28 April 2009 (GS31) and 25 June 2009 (GS 72/75).

Highlighting has been used to indicate virulence of an isolate for adult plants of a cultivar, but has no statistical significance.

Isolates 08/501 and 08/7 were confirmed as pathotype WYV1,2,3,4,6,9,17. These isolates were virulent on cultivars in the WYR6 group, but not on the 'Robigus' or 'Solstice' groups. 08/501 was virulent on Timber, its host cultivar. Although 08/7 had been derived from infected plants of Claire and produced a susceptible reaction on seedlings of the cultivar, there was no evidence of increased virulence for Claire at the adult plant stage.

08/31 was a typical 'Robigus' type, avirulent on WYR6 cultivars and on the Solstice group of cultivars.

08/21 and 08/38 were the first two isolates identified as possessing virulence for Solstice in seedling tests. Their interactions at the adult plant stage mirrored seedling reactions, confirming the susceptibility of the previously resistant cultivars Solstice, Viscount, QPlus and Humber. These isolates also infected WYR6 cultivars and the 'Robigus' group. It is interesting to note that Oakley, which was seedling susceptible to all four WYV 6 isolates, developed substantially higher levels of infection with the Solstice virulent isolates 08/21 and 08/38 than with the non-Solstice virulent isolates 08/501 and 08/7. This is consistent with field observations indicating that Oakley has become more susceptible during the past two seasons, coinciding with the emergence of virulence for Solstice. It appears that 'Solstice' types may be better adapted to some component of Oakley's adult plant resistance than were previous WYV6 pathotypes.

None of the isolates tested possessed virulence for WYR7, hence the resistance of cultivars Brock, Cordiale and Grafton, which carry this resistance. Similarly, JB Diego was resistant to all isolates, although it is known to show susceptibility to some existing pathotypes not represented here.

Amongst the other resistant varieties, Cadenza, Panorama and Scout were resistant to all isolates at the seedling stage as well as the adult plant stage, indicating the involvement of resistances of the overall type. Gladiator showed susceptibility to some isolates at the seedling stage, but resistance to others, suggesting that it may carry a combination of seedling and AP resistances. Cassius was susceptible to all isolates at the seedling stage, indicating resistance of the adult plant type.

Table 7. Adult Plant Tests: % leaf area infected with yellow rust (mean of 9 assessments)
* = probable contamination, avirulent in seedling tests

Cultivar	WYR	08/501 1,2,3,4,6,9,17, Tim	08/7 1,2,3,4,6,9,17, Cla	08/30 1,2,3,4,9,17,32, Rob	08/21 1,2,3,4,6,9,17,32, (Rob),Sol	08/38 1,2,3,4,6,9,17,32, Rob,Sol
Hornet	6,9	12.50	16.10	2.42	10.67	18.94
Mascot	6,17	11.11	8.20	0.22	6.34	9.03
Haven	6,9	8.67	7.74	0.29	5.94	8.50
Ketchum	6	8.22	6.89	0.94	7.42	7.84
Napier	6,9,17	8.53	7.68	0.19	5.33	7.76
Marksman	17+(6)	5.20	3.39	0.02	3.30	4.40
Duxford	6+	3.99	4.38	0.07	1.96	3.88
Walpole	6+	3.73	3.96	0.03	3.64	2.32
Battalion	17+(6)	1.97	1.99	0.01	2.26	4.50
Einstein	6+	1.83	2.31	0.01	2.73	2.46
Oakley	6+	5.31	4.77	6.62*	22.33	21.56
Robigus	32+ (Rob)	3.04	2.57	27.17	21.00	17.67
Hereward	32+	0.03	0.80	6.02	3.71	3.16
Talon	32	0.01	2.57	8.98	6.04	7.12
Conqueror	Rob AP	1.93	3.28	8.56	6.33	6.67
Oxbow	Rob	0.09	7.26	15.33	10.72	9.26
Solstice	Sol	0.13	1.58	1.31	13.56	13.22
Viscount	Sol	0.20	1.00	0.96	10.83	10.89
Qplus	Sol	0.09	0.49	0.00	9.42	7.76
Humber	Sol ?	0.17	0.10	0.03	3.62	6.29
Timber	Tim	8.26	3.67*	0.01	0.20	0.07
Slejpner	9	26.00	20.89	33.89	28.89	28.51
Brigadier	9,17	19.00	21.39	36.56	20.11	21.28
Clement	9	15.72	11.82	14.64	8.09	10.01
Reaper	17	10.78	7.56	10.17	8.17	9.78
Vuka	0	7.61	7.68	9.61	7.44	8.94
Hobbit	14	8.17	7.51	8.21	5.60	8.14
Gallant	?0	4.11	2.82	4.37	3.38	3.13
M. Huntsman	13	2.90	0.79	2.02	1.52	1.79
Brock	7	0.00	0.00	0.00	0.06	0.00
Cordiale	7	0.00	0.00	0.01	0.07	0.00
Grafton	7	0.00	0.00	0.00	0.00	0.00
Scout	x+APR	0.00	0.00	0.00	0.03	0.00
Gladiator	?	0.54	0.26	0.61	0.16	0.51
Panorama	Sol +?	0.00	0.00	0.01	0.60	0.41
JB Diego	?	0.00	0.01	0.14	0.46	0.33
Istabraq	x+APR	0.03	0.03	0.53	0.23	0.04
Alchemy	x+APR	0.09	0.01	0.09	0.22	0.40
Claire	x+APR	0.10	0.04	0.19	0.24	0.09
Buster	R	0.00	0.10	0.20	0.13	0.09
Cassius	APR	0.01	0.00	0.10	0.00	0.07
Cadenza	R	0.00	0.00	0.00	0.00	0.00

REFERENCE

Priestley R H, Bayles R A and Thomas J E (1984). Identification of specific resistances against *Puccinia striiformis* (Yellow Rust) in winter wheat varieties. 1. Establishment of a set of type varieties for adult plant tests. *Journal of the National Institute of Agricultural Botany*, **16,** 469-476.

UKCPVS 2009 ANNUAL REPORT

BROWN RUST OF WHEAT

R A BAYLES and A M WELLS

Virulence for Robigus was detected in fewer than 20% of the isolates tested in 2009. There was confirmation that the cultivars Oakley, Scout and Viscount are susceptible to isolates with virulence for Robigus. For the first time for over 10 years, no virulence was detected for *Lr26*.

INTRODUCTION

Brown rust was not a major problem in 2009, generally appearing late in the season and being less widespread than in some recent years.

2009 ISOLATES: SEEDLING VIRULENCE TESTS

METHODS

11 isolates were tested from 8 different wheat cultivars (Table 1).

Table 1. Cultivars from which brown rust isolates were tested

Cultivar	R genes/factors	1-9* rating	No. isolates tested
Scout	? R 'Robigus'	9	1
Viscount	R 'Robigus'	9	1
Cassius	?	8	1
Claire	R 'Claire'	5	1
Panorama	*?*	4	1
Alchemy	R 'Claire'	4	2
Glasgow	*Lr1*	3	2
Solstice	*Lr13*	3	2
TOTAL			11

*HGCA Recommended List for 2010/2011

Table 2 shows the locations from which the samples were collected. The majority were from Cambridgeshire.

Table 2. Locations from which brown rust isolates were tested

Region	County	No. of isolates tested
East Anglia	Cambridgeshire	8
	Norfolk	1
Yorkshire	East Yorkshire	2
TOTAL		11

METHODS

Isolates were tested for virulence on seedlings of three sets of wheat lines: 1) the standard WBR differential cultivars, 2) selected 'Thatcher' Near Isogenic Lines (NILS) carrying different *Lr* resistance genes, and 3) current UK cultivars with known or unknown resistance genes (Table 3).

Seedlings of the differential cultivars were grown in a spore-proof glasshouse and inoculated at the first leaf stage with a spore: talc mixture, using a rotary inoculator. Inoculated seedlings were placed in a sealed polythene bag in a refrigerator at 5^{o}C for 48 hours in the dark. They were then transferred to a controlled environment growth room where they were maintained at a constant temperature of 20^{o}C (12 hour photoperiod) for 12-14 days, after which they were assessed for reaction type.

Table 3. Differential cultivars used in 2009 seedling virulence tests

Differential cultivar	WBR factor	*Lr* gene
Standard WBR cultivars		
Clement	WBR 1	*Lr26*
Fundin	WBR 2	*Lr17b*
Sappo	WBR 3	*Lr20*
Halberd	WBR 4	*Lr20*
Sterna	WBR 7	*Lr3a*
Armada	WBR 0	
Thatcher near isogenic lines		
Tc*6/Centenario		*Lr1*
Tc*6/ST-1.25		*Lr26*
Tc*8/VPM1		*Lr37*
Additional cultivars		
Glasgow		*Lr1*
Robigus	'Rob'	
Oakley	'Rob'	
Viscount	'Rob'	
Scout	? 'Rob'	
Alchemy	'Claire'	
Mascot		*Lr37*
Gladiator		*Lr26, Lr37*
Battalion		*Lr37+*
Timber	R	
Cassius	?	

RESULTS

Seedling virulence frequencies are shown in Table 4. These should be interpreted with caution because of the lower than usual number of isolates tested.

Several of the resistances covered by the differential set are of the adult plant type and are not expressed consistently at the seedling stage. This accounts for the apparently high level of virulence for these resistances in seedling tests. The most important of these are *Lr37* and the 'Claire' resistance.

Certain other resistances, including *Lr1*, *Lr26*/WBR1 and the resistance of Robigus are of the overall type, and are expressed at both seedling and adult plant stages. Virulence for *Lr26*/WBR1 was not detected in any isolate and virulence for *Lr1* and virulence for Robigus were each detected in only two isolates.

As in 2008, there was evidence of an association between virulence for Robigus, Oakley, Viscount and Scout.

No virulence was detected for Timber.

Table 4. Virulence frequencies 2000 - 2009

Virulence for		% Frequency								
		00	01	02	03	05	06	07	08	**09**
WBR cvs										
Clement	WBR 1	82	100	84	73	69	44	21	24	**0**
Fundin	WBR 2	60	94	56	73	100	100	100	86	**91**
Sappo	WBR 3	8	0	0	0	13	28	8	5	**0**
Halberd	WBR 4	4	0	0	0	13	24	8	10	**9**
Sterna	WBR 7	61	65	50	68	56	68	8	14	**0**
Armada	WBR 0	100	100	100	100	100	100	100	100	**100**
Thatcher NILs										
Tc*6/Centenario	*Lr1*	0	0	0	0	28	32	13	14	**18**
Tc*6/ST-1.25	*Lr26*	83	100	73	73	69	44	17	33	**0**
Tc*8/VPM1	*Lr37*						100	30	91	**27**
Additional cultivars										
Glasgow	*Lr1*						32	17	19	**18**
Robigus	'Rob'						32	30	10	**18**
Oakley	'Rob'							17	14	**9**
Viscount	'Rob'								10	**9**
Scout	? 'Rob'								14	**18**
Alchemy	R 'Claire'						100	58	100	**100**
Mascot	*Lr37*							22	100	**82**
Gladiator	Lr26,Lr37								19	**9**
Battalion	*Lr37+*							17	91	**64**
Timber	R							0	0	**0**
Cassius	?								52	**27**
No. of isolates tested		23	17	14	22	32	25	24	21	**11**

2008 ISOLATES: ADULT PLANT TESTS

METHODS

5 isolates from the 2008 survey (Table 5) were tested on a set of 45 cultivars in adult plant tests in field isolation nurseries. Seedling tests of the same isolates and cultivars were carried out under standard controlled environment conditions.

Table 5. Isolates tested on adult plants in 2007

Code	Cultivar	Location	Virulence for (seedling stage)		
08/07	Solstice	Hampshire	WBR1,2	Lr26	Glasgow
08/09	Battalion	Cambridgeshire	WBR1,2,3,7	Lr1,26	Glasgow
08/12	Glasgow	Cambridgeshire	WBR2	Lr1	Glasgow
08/15	Robigus	Cambridgeshire	WBR2		Robigus, Oakley
08/23	Oakley	Cambridgeshire	WBR2,7		Robigus, Oakley

RESULTS AND DISCUSSION

The results of adult plant tests are shown in Table 6.

Data are mean leaf area infection values for 4 assessments taken at weekly intervals between GS 68 and GS 85 (11 June – 2 July).

Highlighting has been used to indicate virulence of an isolate for adult plants of a cultivar, but has no statistical significance. The darker shading indicates higher levels of infection and the lighter shading intermediate levels, but the distinction is highly subjective. It was noticeable that the first two isolates, 08/07 and 08/09 tended to produce lower infection values overall because the brown rust epidemic was relatively slow to establish in these nurseries.

The first three isolates in the table, 08/07, 08/09 and 08/12 were clearly avirulent on Robigus at seedling and adult plant stages. Isolates 08/15 and 08/23 were virulent on Robigus at all stages and produced moderate to high levels of infection on adult plants. The reactions of Oakley, Viscount, QPlus and Scout paralleled those of Robigus.

Isolate 08/23 appeared similar to the Robigus-virulent isolates tested in 2008, giving only low levels of infection on varieties carrying the Claire adult plant resistance, varieties in the *Lr26* or *Lr37* groups or on Glasgow (*Lr1*). 08/15 however displayed a broader spectrum of virulence, giving high levels of infection on the Claire group of varieties as well as the Robigus group.

The group of varieties listed from Duxford to Panorama, with unknown resistances, were broadly susceptible to all isolates at the seedling stage. Levels of infection varied between isolates at the adult plant stage, with a distinct trend towards higher levels of infection with isolates towards the right of the table.

Varieties from Armada to Hereford were susceptible to all isolates at both seedling and adult plant stages.

The final three cultivars in the table, Timber, Cassius and Maris Ranger, were the only ones to maintain high levels of resistance to all isolates. Of these, Timber has an overall resistance which is effective at seedling as well as adult, stages; Cassius is susceptible to some isolates at the seedling stage, indicating that it may carry a combination of overall and adult plant resistance. Maris Ranger was susceptible to all isolates at the seedling stage, consistent with an adult plant type resistance.

Table 6. Adult Plant Tests: % leaf area infected with brown rust (mean of 4 assessments)

Cultivar	R factors	08/07	08/09	08/12	08/15	08/23
Robigus	'Rob'	0.25	4.00	0.63	40.50	48.50
Oakley	'Rob'	1.53	1.40	0.40	45.63	41.13
QPlus	'Rob'	0.00	1.03	0.00	34.38	20.63
Viscount	'Rob'	0.13	0.63	0.00	15.13	6.78
Scout	'Rob'	0.00	0.00	0.00	15.53	2.25
Claire	Claire'	6.88	8.40	22.00	30.63	1.03
Alchemy	Claire'	8.53	15.50	26.88	29.63	3.28
Istabraq	Claire'	17.50	11.13	27.88	32.88	1.68
M. Huntsman	*Lr13*	6.25	13.70	15.50	25.00	29.75
Solstice	*Lr13*	9.38	16.75	26.00	40.63	27.13
Consort	*Lr10,Lr13*	30.38	19.38	36.63	39.00	38.13
Einstein	*Lr10*	6.93	11.00	25.38	20.13	14.38
Clement	*Lr26*	3.50	14.50	15.63	6.13	5.40
Tanker	*Lr26*	13.28	23.00	24.00	8.40	2.65
Slejpner	*Lr26*	6.28	16.00	15.50	5.53	4.28
Gladiator	*Lr26, Lr37*	2.13	6.15	7.63	0.28	0.38
Savannah	*Lr26, Lr37*	2.05	8.75	11.38	0.28	0.00
Brigadier	*Lr26, Lr37*	18.38	22.88	36.00	7.03	6.38
Napier	*Lr26, Lr37*	5.40	15.63	17.00	1.15	3.63
Reaper	*Lr37*	7.75	22.00	17.75	2.75	2.90
Mascot	*Lr37*	12.90	18.15	29.63	1.28	1.53
Humber	*Lr37*	6.63	12.63	24.00	0.78	0.75
Conqueror	*?*	5.88	16.90	17.25	0.78	0.20
Battalion	*Lr37+*	0.40	4.53	0.65	0.00	0.00
Marksman	*Lr37+*	0.95	5.40	4.00	0.00	0.00
Glasgow	*Lr1*	18.88	32.75	45.63	37.50	9.53
Duxford	?	4.38	10.78	17.88	11.63	33.38
JB Diego	?	9.95	10.00	19.38	33.50	20.50
Walpole	?	7.53	10.28	14.75	15.15	26.63
Ketchum	?	2.30	3.98	9.75	12.75	22.00
Gallant	?	2.53	7.15	18.38	18.13	38.75
Panorama	?	3.55	5.78	19.25	3.25	34.50
Soissons	*Lr14a*	3.03	13.13	1.40	0.25	0.15
Sterna	WBR 7	1.90	3.15	2.40	0.00	0.13
Maris Fundin	WBR 2	17.00	16.63	23.75	35.38	45.63
Gamin	WBR 6	5.93	6.03	24.15	16.88	17.13
Armada	WBR 0	13.75	13.25	15.50	17.50	26.88
Avalon	WBR 9	28.00	28.25	33.00	37.75	46.25
Cordiale	?	20.63	25.13	26.38	33.75	43.38
Grafton	?	13.50	23.75	25.25	24.63	42.50
Buster	'Buster'	33.38	33.50	52.50	48.75	53.75
Hereford	?	24.63	29.00	47.88	52.50	36.50
Timber	R	0.00	0.00	0.00	0.03	0.00
Cassius	?	0.13	1.90	1.33	0.00	0.00
Maris Ranger	WBR 8	0.13	0.88	0.25	0.05	0.00