

UKCPVS 2010 ANNUAL REPORT

MILDEW OF WHEAT

R A BAYLES and R E BORROWS

The virulence composition of the mildew population has remained very stable. Virulence corresponding to widely used winter wheat resistances remained high, while virulence corresponding to resistances from spring wheat backgrounds remained at low to moderate levels. Virulence for Robigus has not increased and remained at a moderate level

METHODS

69 single pustule isolates were tested in 2010. These comprised 44 isolates made from infected leaf samples collected from 13 different wheat cultivars (Tables 1 and 2) and 25 isolates from the universally susceptible cultivar Cerco exposed in mobile seedling trap nurseries (Table 3).

Table 1. Cultivars from which leaf sample isolates were tested

Cultivar	Rgenes/factors	1-9 rating*	No. of isolates tested
Ketchum	?	8	2
Humber	<i>Pm8</i>	7	2
Cordiale	Mld	6	3
Denman	?	6	6
Duxford	?	6	3
Einstein	<i>Pm2+</i>	6	2
Oakley	MIRo	6	5
Robigus	MIRo	6	6
Beluga	?	5	1
Gallant	?	5	7
Hereward	0	5	1
Claire	<i>Pm2,Pm4b</i>	4	4
Solstice	0	4	2
TOTAL			44

* HGCA Recommended List 2011/2012 or most recent available data

Table 2. Locations from which leaf sample isolates were tested

<u>Location</u>	<u>No. of isolates</u>
Cambridgeshire	10
Herefordshire	5
Shropshire	25
Scotland	4
TOTAL	44

Table 3. Locations of trap nursery from which isolates were tested

<u>Location</u>	<u>No. of isolates</u>
Cambridgeshire	9
Essex	7
Kent	1
Leicestershire	5
Suffolk	2
Warwickshire	1
TOTAL	25

Isolates were tested for virulence in detached leaf tests using the differential cultivars and additional cultivars listed in Table 4.

Table 4. Differential cultivars used to determine virulence factors

Differential cultivar	Resistance Factors (European Codes)	Resistance genes
<u>Standard set</u>		
Cerco	0	0
Galahad	Pm2	<i>Pm2</i>
Chul	Pm3b	<i>Pm3b</i>
Armada	Pm4b	<i>Pm4b</i>
Flanders	Pm5	<i>Pm5</i>
Brimstone	Pm6	<i>Pm6</i>
Clement	Pm8	<i>Pm8</i>
Maris Dove	Mld	<i>Mld</i>
Brock	Pm2, MITa2	<i>Pm2, MITa2</i>
Mercia	Pm5, MITa2	<i>Pm5, MITa2</i>
Tonic	MITo	<i>Pm3d+?</i>
Broom	Pm3d	<i>Pm3d</i>
Sicco	Pm5, MISi2	<i>Pm5, MISi2</i>
Wembley	MISo	<i>MISo</i>
Axona	MIAx	<i>MIAx</i>
Amigo	Pm17	<i>Pm17</i>
Shamrock	MlSh	?
<u>Additional cultivars</u>		
Battalion	?Mld	
Beluga	?	
Cassius	?	
Conqueror	?MIRo	
Gallant	?	
Grafton	?	
Hyperion	?Mld	
Invicta	?	
Ketchum	?	
Kingdom	?	
KWS-Sterling	?	
Panorama	?	
QPlus	?	
Robigus	MIRo	
Scout	?	
Stigg	R	
Timber	MITi	
Viscount	?MIRo	
Warrior	R	

RESULTS AND DISCUSSION

Virulence frequencies are shown in Table 5.

Table 5. Virulence frequencies 1999 - 2010

Virulence for	Frequency of virulence %									
	1999	2000	2001	2002	2003	2004	2005	2006	2008	2010
<i>Pm2</i>	100	100	100	99	100	100	99	100	95	78
<i>Pm3b</i>	2	1	4	6	7	4	25	10	8	10
<i>Pm4b</i>	99	99	100	100	100	100	97	99	97	75
<i>Pm5</i>	91	88	90	89	92	90	92	95	92	71
<i>Pm6</i>	100	99	100	100	100	99	97	98	84	87
<i>Pm8</i>	99	97	98	98	94	98	90	98	62	74
<i>Mld</i>	6	12	25	24	18	18	30	31	23	20
<i>Pm2, MITa2?</i>									89	99
<i>Pm5, MITa2?</i>	97	96	95	99	96	97	97	98	80	67
MITo	16	5	24	20	20	20	27	36	24	22
<i>Pm3d</i>	15	8	24	27	20	21	30	37	25	26
<i>Pm5, MlSi2</i>	20	8	8	15	6	6	20	9	11	1
<i>MlSo</i>	6	4	6	11	4	4	16	10	5	3
<i>MlAx</i>	1	1	10	8	8	9	13	23	16	15
<i>Pm17</i>	22	2	9	13	4	6	11	9	6	0
MlSh	3	0	4	16	8	1	5	1	0	6
<u>Additional cvs</u>										
Battalion									34	36
Hyperion								32	34	36
Ketchum									34	35
Robigus							46	27	35	33
Timber								7	16	1
Beluga										87
Cassius										90
Conqueror										44
Gallant										25
Grafton										36
Invicta										36
Kingdom										23
KWS-Sterling										34
Panorama										36
QPlus										71
Robigus										33
Scout										86
Stigg										0
Viscount										27
Warrior										0
No. isolates tested	187	148	286	165	209	376	219	160	110	69

Overall, the virulence composition of the UK mildew population appears to have remained remarkably stable over the past ten years or so, despite the first detection of virulence for Robigus in 2005 and for Timber in 2006.

Virulence for *Pm2*, *Pm4b*, *Pm5*, *Pm6*, *Pm8* and *MTa* remained at high frequencies, demonstrating that they are largely ineffective against the current mildew population. As noted in previous reports, these resistances have been used extensively in UK winter wheat breeding over many years. Amongst cultivars tested for the first time in 2010, it seems likely that Cassius, Conqueror, QPlus and Scout, all with high levels of corresponding virulence, carry one of these resistances.

Virulence for resistances derived from spring wheat, such as *MLAx*, *MITo*, *Mld* and *Pm3d*, remained at intermediate levels, in the range 27% to 44%. There were clear indications in the dataset that the cultivars Battalion, Gallant, Kingdom, Grafton, KWS-Sterling, Panorama and Ketchum, carry one or other of these spring wheat resistances.

Virulence for Robigus has shown no signs of increasing since it was first detected and remains at around 30-40%. The cultivars Viscount, Conqueror and Invicta were very similar to Robigus in their patterns of interactions with isolates, suggesting that they have a resistance in common.

Virulence for Timber was detected in only a single isolate, reflecting the disappearance of this cultivar from commerce.

Virulence for Shamrock, which was absent in 2008, was picked up again in a small number of isolates.

Virulence has still not been detected for the resistances of the newly introduced cultivars Stigg and Warrior.

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BROWN RUST OF WHEAT

R A BAYLES and R E BORROWS

Moderate levels of virulence were detected again after a year's absence for *Lr26*/WBR1. However, in contrast to recent years, no virulence was detected for Robigus or for *Lr1*. Cultivars Timber (*Lr24*) and Warrior maintained their resistance to all isolates.

INTRODUCTION

2010 was another year of low brown rust incidence, similar to 2009.

2010 ISOLATES: SEEDLING VIRULENCE TESTS

METHODS

10 isolates were tested from 9 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
Warrior	R	9	1
Brentano	?	8	1
KWS-Target	?	6	1
Alchemy	R 'Claire'	5	2
Conqueror	?	5	1
Beluga	?	4	1
KWS Santiago	?	4	1
KWS-Solo	?	4	1
TOTAL			10

*HGCA Recommended List for 2011/2012

The majority of samples were collected in Cambridgeshire (Table 2).

Table 2. Locations from which brown rust isolates were tested

Region	County	No. of isolates tested
East Anglia	Cambridgeshire	7
South East	Kent	1
West Midlands	Shropshire	2
TOTAL		10

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 controlled environment growth room 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°C for 48 hours in the dark. They were then returned to a growth room where they were maintained at a constant temperature of 20°C (12 hour photoperiod) for 12-14 days, after which they were assessed for reaction type.

Table 3. Differential cultivars used in 2010 seedling virulence tests

Differential cultivar	WBR factor	<i>Lr</i> gene
<u>Standard WBR cultivars</u>		
Clement	WBR 1	<i>Lr26</i>
Fundin	WBR 2	<i>Lr17b</i>
Sappo	WBR 3	<i>Lr20</i>
Halberd	WBR 4	<i>Lr20</i>
Sterna	WBR 7	<i>Lr3a</i>
Armada	WBR 0	
<u>Thatcher near isogenic lines</u>		
Tc*6/Centenario		<i>Lr1</i>
Tc*6/ST-1.25		<i>Lr26</i>
Tc*8/VPM1		<i>Lr37</i>
<u>Additional cultivars</u>		
Glasgow		<i>Lr1</i>
Robigus	'Rob'	
Viscount	'Rob'	
Scout	? 'Rob'	
Alchemy	'Claire'	
Mascot		<i>Lr37</i>
Timber	R	<i>Lr24</i>
Cassius	?	
Conqueror	?	
Beluga	?	
Warrior	?	

RESULTS

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

Virulence for *Lr26*/WBR1 was detected again in a significant number of isolates, following its absence from 2009 isolates.

No virulence was detected for Robigus, Viscount or Scout, which have previously shown susceptibility to the same isolates. Virulence for Robigus has never been widely detected, being at a maximum of 32% in 2006 when it was first identified.

Virulence for *Lr1* and Glasgow was also absent from isolates in 2010.

Several of the resistances covered by the differential set are not expressed consistently at the seedling stage. This accounts for the apparently high level of virulence for resistances such as *Lr37* and the 'Claire' resistance in seedling tests.

Warrior remained resistant to all isolates, including one which was believed to have come from an infected plot of this cultivar.

Virulence has still not been detected for Timber.

Table 4. Virulence frequencies 2001 - 2010

Virulence for		%								
		Frequency								
		01	02	03	05	06	07	08	09	10
<u>WBR cvs</u>										
Clement	WBR 1	100	84	73	69	44	21	24	0	70
Fundin	WBR 2	94	56	73	100	100	100	86	91	70
Sappo	WBR 3	0	0	0	13	28	8	5	0	0
Halberd	WBR 4	0	0	0	13	24	8	10	9	0
Sterna	WBR 7	65	50	68	56	68	8	14	0	90
Armada	WBR 0	100	100	100	100	100	100	100	100	100
<u>Thatcher NILs</u>										
Tc*6/Centenario	<i>Lr1</i>	0	0	0	28	32	13	14	18	0
Tc*6/ST-1.25	<i>Lr26</i>	100	73	73	69	44	17	33	0	40
Tc*8/VPM1	<i>Lr37</i>					100	30	91	27	100
<u>Additional cultivars</u>										
Glasgow	<i>Lr1</i>					32	17	19	18	0
Robigus	'Rob'					32	30	10	18	0
Viscount	'Rob'							10	9	0
Scout	? 'Rob'							14	18	0
Alchemy	R 'Claire'					100	58	100	100	100
Mascot	<i>Lr37</i>						22	100	82	100
Timber	R (<i>Lr24</i>)						0	0	0	0
Cassius	?							52	27	100
Conqueror	?									100
Beluga	?									100
Warrior	?									0
No. of isolates tested		17	14	22	32	25	24	21	11	10

2009 ISOLATES: ADULT PLANT TESTS

METHODS

2 isolates from the 2009 survey (Table 5) were tested on a set of 46 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 2010

Code	Cultivar	Location	Virulence for (seedling stage)	
09/20	Viscount	Cambridgeshire	WBR2	Robigus
09/24	Glasgow	Yorkshire	<i>Lr1</i>	

RESULTS AND DISCUSSION

The results of adult plant tests are shown in Table 7.

Data are mean leaf area infection values for 7 assessments made at approximately 7-day intervals between GS 68 and GS 85 (11 June – 2 July).

Highlighting has been used to indicate compatibility between isolates and cultivars, but has no statistical significance.

A number of cultivars (Table 6) became heavily contaminated with yellow rust, making it impossible to assess their susceptibility to brown rust. The data for these has been omitted.

Table 6. Cultivars excluded due to high levels of yellow rust contamination

Cultivar	Brown rust Resistance
Solstice	<i>Lr13</i>
Robigus	'Rob'
Oakley	'Rob'
Viscount	'Rob'
Conqueror	'Rob'
Clement	<i>Lr26</i>
Brigadier	<i>Lr26,Lr37</i>
Savannah	<i>Lr26,Lr37</i>
Mascot	<i>Lr37</i>

Table 7. Adult Plant Tests: % leaf area infected with brown rust (mean of 7 assessments)

Cultivar	R factors	RL rating*	09/20	09/24
Buster	?		42.8	49.2
Hereford	WBR0		39.7	24.3
Consort	<i>Lr10,Lr13</i>		24.3	32.5
Avalon	WBR9		25.0	21.0
JB Diego	?	4	22.5	20.7
Maris Fundin			16.7	25.3
Cordiale	?	3	20.8	20.5
Grafton	?	3	22.7	17.5
Duxford	?	4	16.0	23.7
Panorama	?	4	15.7	20.0
Armada	WBR0		15.8	13.6
Einstein	<i>Lr10</i>	5	11.2	18.0
Claire	'Claire'	5	18.8	9.7
Alchemy	'Claire'	5	16.7	11.4
Gallant	?	4	8.5	19.8
Beluga	?	4	17.7	9.7
Ketchum	?	5	11.8	12.0
KWS-Curlew		4	8.0	14.7
Kingdom	?	4	6.2	12.2
Gamin			9.1	8.3
Soissons	<i>Lr14a</i>		8.8	6.0
Qplus	'Rob'	7	23.5	1.7
Invicta	?	8	23.2	4.8
KWS-Horizon	?	5	22.0	4.5
Scout	'Rob'	9	17.0	3.0
Glasgow	<i>Lr1</i>	3	3.0	37.0
Edmunds		5	2.6	22.0
KWS- Sterling	?	7	2.7	14.3
Cassius	?	8	0.8	13.3
Tanker	<i>Lr26</i>		3.3	5.3
Battalion	Lr37+	8	3.7	5.0
KWS-Quartz		8	1.0	6.2
Humber	<i>Lr37</i>	5	3.7	2.3
Sterna			0.5	1.2
Maris Ranger			0.0	0.3
Timber	<i>Lr24</i>	9	0.0	0.0
Warrior	R	9	0.0	0.0

* HGCA Recommended List for 2011/12, or most recent available

Both isolates produced moderate to high levels of infection on cultivars carrying the resistances *Lr10*, *Lr13*, *Lr14a*, WBR2, WBR6, WBR9 and the 'Claire' resistance. Neither showed virulence for *Lr26*, *Lr37*, WBR7 or WBR8. Timber (*Lr24*) and Warrior maintained their complete resistance when challenged with both isolates.

The isolates were differentiated by their interactions with two small groups of cultivars. Whilst 09/20 gave high levels of infection on QPlus, Invicta, KWS-Horizon and Scout, but low levels on Glasgow, Edmunds, KWS-Sterling and Cassius, the opposite was true of 09/24. In the first of these groups, QPlus and Scout (along with Viscount, the cultivar from which 09/20 originated) have previously been identified as possible carriers of the Robigus resistance. The results here lend further support to this suggestion and also indicate that Invicta and KWS-Horizon may be in the same group. QPlus, Invicta and Scout certainly appear to be potentially more susceptible than suggested by their RL disease resistance ratings. This could be partly explained by the relative un-commonness of virulence for the 'Robigus' resistance in the UK brown rust population.

The second group of cultivars included Glasgow (the source cultivar for 09/24), believed to carry *Lr1*. The resistances of the other three cultivars are unknown, but KWS-Sterling and Cassius both appear to be more susceptible to 09/24 than would be expected from their resistance ratings. This may be an early warning of changing virulence in the UK brown rust population.

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YELLOW RUST OF WHEAT

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Most isolates tested in 2010 were once again of the 'Solstice' pathotype, WYV 1,2,3,4,6,9,17,32, 'Rob', 'Sol'. There was no evidence of increased virulence for previously resistant cultivars.

INTRODUCTION

There was only a moderate incidence of yellow rust in farm crops in 2010, mainly in the highly susceptible cultivar Oakley. However, towards the end of the season, the disease developed to severe levels in many variety trials and observation plots where fungicides had not been routinely applied.

2010 ISOLATES: SEEDLING VIRULENCE TESTS

METHODS

40 isolates were selected for virulence testing on the basis of the cultivar and location from which samples had been collected.

Isolates tested came from 14 different wheat cultivars and also from 6 cultivars of Triticale (Table 1). 17 of the 34 isolates from wheat were from highly resistant cultivars with the highest rating of 9 on the HGCA Recommended List.

The large majority of isolates came from the high risk eastern counties of England, but there were also a number from the West Midlands, South West and Scotland.

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
Alchemy	9	2
Beluga	9	2
Cassius	9	1
Claire	9	2
Edmunds	9	1
Panorama	9	3
Tuxedo	9	1
Warrior	9	5
Cocoon	8	1
Humber	8	1
Invicta	8	3
Denman	7	3
KWS-Santiago	6	1
Oakley	2	8
Triticale (6 cvs)		6
TOTAL		40

*HGCA Recommended List 2011/12.

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

Region	County	No. of isolates tested
East Anglia	Cambridgeshire	22*
	Suffolk	1
East Midlands	Leicestershire	1
	Lincolnshire	8
	Northamptonshire	1
West Midlands	Herefordshire	1
	Warwickshire	1
South East	Bedfordshire	2
	Kent	1
South West	Devon	1
Scotland	Lothian	1
TOTAL		40

* includes 6 isolates from Triticale

Table 3. Differential cultivars used in 2010 seedling virulence tests

Differential cultivar	WYR factor	Gene designation
<u>Core set</u>		
Chinese 166	WYR1	<i>Yr1</i>
Kalyansona	WYR2	<i>Yr2</i>
Vilmorin 23	WYR3	<i>Yr3+</i>
Nord Desprez	WYR3	<i>Yr3+</i>
Hybrid 46	WYR4	<i>Yr4</i>
Heines Kolben	WYR2,6	<i>Yr2, Yr6</i>
Heines Peko	WYR2,6	<i>Yr2, Yr6</i>
Lee	WYR7	<i>Yr7</i>
Brock	WYR7	<i>Yr7</i>
Compair	WYR8	<i>Yr8</i>
Kavkaz x 4 Fed	WYR9	<i>Yr9</i>
Clement	WYR9	<i>Yr9</i>
AVS xYr15	WYR15	<i>Yr15</i>
VPM 1	WYR17	<i>Yr17</i>
Rendezvous	WYR17	<i>Yr17</i>
Carstens V	WYR32	<i>Yr32</i>
Talon	WYR32	<i>Yr32</i>
<u>Additional cultivars*</u>		
Robigus (2)	WYR 'Rob'	
Solstice (4)	WYR 'Sol'	
Timber	WYR 'Tim'	
Cadenza	R	
Hornet	WYR6,9	
Alchemy (9)		
Claire (9)		
Beluga (9)		
Cassius (9)		
Cocoon (8)		
Denman (7)		
Edmunds (9)		
Humber (8)		
Invicta (8)		
JB Diego (6)		
KWS-Santiago (6)		
Panorama (9)		
Tuxedo (9)		
Warrior (9)		
Oakley (2)		

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

RESULTS and DISCUSSION

Virulence frequency data for 2010, together with data from 2000-2009, are shown in Table 4.

Table 4. Virulence frequencies (%) from 2000 to 2010

Virulence for	00	01	02	03	04	05	06	07	08	09	10
WYR 1	100	100	97	100	100	100	-	-	100	100	100
WYR 2	100	100	97	100	100	100	-	-	100	100	100
WYR 3	100	100	97	100	93	100	-	-	91	99	100
WYR 4	90	74	63	86	50	87	100	100	81	98	100
WYR 6	32	39	31	50	42	10	19	4	19	90	98
WYR 7	4	0	3	36	4	8	11	4	0	0	24
WYR 8	0	0	0	0	0	0	0	0	0	0	0
WYR 9	92	90	88	93	100	95	100	94	93	93	99
WYR 15		0	0	0	0	0	0	0	0	0	0
WYR 17	96	77	88	93	85	97	100	88	83	87	97
WYR 32	16	42	73	64	38	85	89	92	79	94	95
<u>Additional cvs</u>											
Robigus 'Rob'					31	79	89	84	81	81	100
Solstice 'Sol'									10	69	98
Timber 'Tim'							7	0	5	2	0
Cadenza R		0	0	0	0	0	0	0	0	0	*3
Hornet 6,9							19	4	19	81	98
Alchemy (9)										14	70
Claire (9)						23	0	4	14	43	83
Beluga (9)											70
Cassius (9)											85
Cocoon (9)											85
Denman (7)											100
Edmunds (9)											68
Humber (8)								4	10	67	95
Invicta (8)											95
JB Diego (6)								0	14	31	50
KWS-Santiago (6)											98
Panorama (9)											65
Tuxedo (9)											53
Warrior (9)											**3
Oakley (2)										81	98
No. of isolates	50	31	36	14	48	39	27	25	21	42	40

** late development of restricted susceptible reactions

* not confirmed in further tests in 2011

There were high levels of virulence for WYR1, WYR2, WYR3, WYR4, WYR6, WYR9, WYR32, 'Rob' and 'Sol', with the most common pathotype once again being WYV1,2,3,4,6,9,17,32,'Rob', 'Sol'.

There were indications of virulence for WYR7, with one or other of the two differentials, Lee or Brock, showing intermediate to susceptible reaction types to 10 isolates. A single isolate produced intermediate to susceptible reaction types on Cadenza, but this result was not confirmed in further tests of the isolate carried out during 2011.

Of the nine resistant 'additional cultivars' with resistance ratings of 9, all but one (Warrior) were widely susceptible at the seedling stage to the 2010 isolates. A selection of these isolates will be taken forward to adult plant field tests during 2011. Warrior showed restricted susceptible reactions to a single isolate when assessment was delayed for 4-5 days beyond the normal period for other cultivars. None of the five isolates collected from Warrior showed any evidence of increased virulence for Warrior in seedling tests.

2009 ISOLATES: ADULT PLANT TESTS

METHODS

Seven isolates (Table 5) were tested on a set of 52 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 2010

Code	Year	Location	Cultivar	Virulence at seedling stage
09/27	2009	Lincs	Humber	1,2,3,4,6,9,17,32,Rob,Sol
09/29	2009	Lincs	Panorama	1,2,3,4,6,9,17,32,Rob,Sol
09/42	2009	Cambs	Viscount	1,2,3,4,6,9,17,32,Rob,Sol
09/44	2009	Cambs	Ketchum	1,2,3,4,6,9,17,32,Rob,Sol
09/105	2009	E Yorks	Warrior	1,2,3,4,6,9,17,32,Rob,Sol
09/101	2009	Norfolk	Timber	1,2,3,4,6,9,17,Tim
09/64	2009	Lincs	JBDiego	1,2,3,4,9,17,32,Rob

RESULTS AND DISCUSSION

The results of adult plant tests are presented in Table 6, with corresponding seedling reactions in Table 7. In Table 6, percentage infection levels are expressed as the mean of seven assessments made at weekly intervals between 18 May 2010 (GS33) and 22 June 2010 (GS 70). Highlighting has been used to indicate virulence of an isolate for adult plants of a cultivar, but has no statistical significance.

Results confirmed the virulence of isolates as shown in Table 5. The first five were of the ‘Solstice’ type (V1,2,3,4,6,9,17,32,Rob,Sol). The other two were typical of the ‘Timber’ and ‘Robigus’ types i.e. V1,2,3,4,6,9,Tim and V1,2,3,4,9,17,32,Rob respectively.

An isolate originating from the resistant cultivar Warrior (rating = 9) showed no evidence of virulence for the cultivar at seedling or adult plant stages.

Isolates from Panorama (rating = 9), Humber (8) and JBDiego (6) showed no evidence of adaptation to their host cultivars.

In contrast, the only isolate with virulence for Timber, shown at both seedling and adult stages, was 09/101, derived from the cultivar.

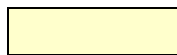
A large majority of current commercial cultivars proved to be susceptible to isolates of the common ‘Solstice’ pathotype at the seedling stage. Some of these cultivars also developed severe levels of infection at adult plant stages. However, many others showed good resistance as adult plants, being evidence that they carry effective resistance(s) of the adult plant type.

Table 6. Adult Plant Tests. % leaf area infected with yellow rust (mean 7 assessments)

		09/27	09/29	09/42	09/44	09/105	09/101	09/64
	R Factors	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,Ti	V1,2,3,4,9,17,32,Ro
Solstice	Sol	7.3	9.8	10.0	9.5	9.1	2.0	6.1
Viscount	Sol	6.8	9.6	10.3	8.0	8.0	2.6	7.3
QPlus	Sol	3.6	6.3	6.2	5.7	5.8	0.1	4.5
Humber	Sol?	2.8	3.5	3.9	3.0	2.2	0.3	0.3
Cocoon	Sol?	1.9	0.5	0.8	1.3	0.9	0.0	0.0
Panorama	Sol+?	0.7	0.8	1.7	1.2	0.1	0.0	0.1
Talon	32	6.9	8.4	6.7	7.8	6.3	0.6	6.5
Robigus	Rob	15.8	14.2	18.2	15.9	16.3	7.2	14.8
KWS Podium	Rob	3.6	5.3	5.7	3.5	4.8	0.9	4.4
Gravitas	Rob?	1.9	3.3	3.9	2.1	1.6	0.1	1.3
Oakley	6+	20.2	14.9	16.8	13.7	10.6	7.9	11.8
Ketchum	6	2.2	2.2	5.8	4.5	2.3	7.5	4.5
Battalion	6,17	3.6	3.7	4.0	4.2	3.1	2.5	1.1
Einstein	6+	2.8	3.8	3.1	3.8	2.7	3.6	1.8
Duxford	6+	0.7	3.1	0.3	3.4	0.5	0.5	0.3
JB Diego	?	2.7	0.7	0.6	3.2	0.6	0.0	3.3
Napier	6,9,17	7.9	8.5	6.2	7.6	6.5	8.1	3.5
Mascot	6,17	6.7	7.2	7.0	6.9	5.8	6.8	2.6
Hornet	6,9	11.6	12.4	10.8	10.4	11.3	10.3	7.4
Timber	Tim	0.5	0.6	0.4	0.1	0.2	6.5	0.1
KWS Santiago	?	7.8	6.8	7.5	8.8	8.0	4.6	5.4
Shire	?	6.6	6.8	8.6	7.7	7.4	1.9	7.4
Conqueror	?	6.0	8.0	8.9	8.1	6.3	3.1	4.7
Invicta	?	4.1	3.3	3.9	3.0	3.2	0.2	5.2
KWS Horizon	?	3.3	3.5	3.8	2.1	2.9	3.1	4.0
Denman	?	1.7	2.6	2.2	0.6	1.3	0.1	2.6
Gallant	?	2.0	1.5	1.3	1.8	0.6	0.7	1.6
Beluga	?	0.7	0.6	2.6	2.1	1.1	0.2	0.2
Kingdom	?	0.9	0.4	2.2	1.5	0.8	0.7	0.2
Slejpner	9	11.4	15.7	13.6	20.1	17.0	18.8	19.3
Brigadier	9,17	21.7	21.8	22.0	20.4	13.1	11.0	21.8
Vuka	0	7.6	9.7	6.4	8.9	8.2	9.1	10.0
Hobbit	14	3.8	7.7	6.0	6.6	6.3	7.5	7.7
M. Huntsman	13	3.8	4.8	4.7	2.5	3.6	3.2	5.8

Table 6 contd. Adult Plant Tests. % leaf area infected with yellow rust (mean 7 assessments)

		09/27	09/29	09/42	09/44	09/105	09/101	09/64
	R Factors	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,Ti	V1,2,3,4,9,17,32,Ro
Brock	7,14	0.0	0.2	0.0	0.0	0.0	0.0	0.1
Cordiale	7	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Grafton	7	0.0	0.0	0.1	0.0	0.0	0.0	0.0
KWS Curlew	?	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KWS Sterling	?	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KWS Quartz	?	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orbit	?	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Stigg	R	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadenza	R	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Claire	x+APR	0.8	0.9	1.5	1.1	1.3	0.1	0.5
Tuxedo	x +APR	1.5	1.0	1.3	0.4	0.2	0.6	0.3
Warrior	x +APR	0.5	0.8	1.1	0.7	0.4	1.0	0.2
Alchemy	x +APR	0.1	0.6	0.5	0.6	1.0	0.0	0.1
KWS Target	x +APR	0.4	0.4	0.5	0.9	0.4	0.0	0.3
KWS Gymnast	x +APR	0.7	0.3	0.4	1.4	0.1	0.0	0.1
Zebedee	x +APR	0.8	0.2	0.2	0.4	0.5	0.1	0.1
Edmunds	x +APR	0.2	0.0	0.1	0.3	0.1	0.1	0.1
Cassius	x +APR	0.0	0.0	0.3	0.1	0.1	0.0	0.0
Scout	x +APR	0.1	0.1	0.0	0.1	0.1	0.0	0.0



high level of infection indicating compatible cultivar x isolate interaction



high level of infection, but probably due to contamination in field by another pathotype



low level of infection indicating incompatible cultivar x isolate interaction

Table 7 Seedling reactions to 7 isolates tested in adult plant tests

	5 'Solstice type' ¹	09/101	09/64		5 'Solstice type'	09/101	09/64
	V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,Ti	V1,2,3,4,9,17,32,Ro		V1,2,3,4,6,9,17,32,Ro,So	V1,2,3,4,6,9,17,Ti	V1,2,3,4,9,17,32,Ro
Solstice	S	R	R	Brock	R	R	R
Viscount	S	R	R	Cordiale	R	R	R
QPlus	S	R	R	Grafton	R	R	R
Humber	S	R	R	KWS Curlew	R	R	R
Cocoon	S	R	R	KWS Sterling	R	R	R
Panorama	S	R	R	KWS Quartz	R	R	R
Talon	S	R	S	Orbit	R	R	R
Robigus	S	R	S				
KWS Podium	S	R	S	Stigg	R	R	R
Gravitas	Var	R	S	Cadenza	R	R	R
Oakley	S	S	R				
Ketchum	S	R	R	Claire	S	S	S
Battalion	S	S	R	Tuxedo	Var	R	R
Einstein	S	S	R	Warrior	R	S	R
Duxford	Var	S	R	Alchemy	S	S	S
JB Diego	S	R	S	KWS Target	S	R	S
Napier	S	S	R	KWS Gymnast	Var	R	S
Mascot	S	S	R	Zebedee	S	S	S
Hornet	S	S	R	Edmunds	S	S	R
Timber	R	S	R	Cassius	S	S	S
				Scout	Var	R	S
KWS Santiago	S	S	S				
Shire	S	S	S				
Conqueror	S	S	S				
Invicta	S	S	S				
KWS Horizon	Var	R	R				
Denman	S	S	S				
Gallant	S	S	S				
Beluga	S	S	S				
Kingdom	S	S	S				
Slejpner	S	S	S				
Brigadier	S	S	S				
Vuka	S	S	S				
Hobbit	S	S	S				
M. Huntsman	S	S	S				

¹ 09/27, 09/29, 09/42, 09/44, 09/105

REFERENCE

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