

Rust resistance genotypes and expected rust responses of Australian common wheat, durum wheat and triticale varieties

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The rust responses for Australian wheat and triticale varieties provide growers and technical advisors with updated information to make informed decisions. The varietal responses for wheat and triticale presented in this report are the consensus opinion of Australian cereal pathologists and breeders and are based on the most recent field trial reports as well as previous data sets. They are developed in the context of the prevailing rust pathotypes recorded in 2019 by surveys undertaken by staff at the University of Sydney's Plant Breeding Institute. Gene postulations based on multi-pathotype tests (12 pathotypes each of wheat stripe rust, wheat stem rust, and wheat leaf rust) and pathogen survey results help in explaining regional rust response variation, and in predicting varietal vulnerability to rust. In this issue we have separated the postulated all stage effective resistance (ASR; seedling resistance) and adult plant resistance (APR) genes, and also provide presence/ absence information for the rust resistance genes *Lr34/Yr18/Sr57*, *Lr46/Yr29/Sr58*, *Lr67/Yr46/Sr55*, *Lr37/Yr17/Sr38*, *Lr24/Sr24*, and *Sr2* based on marker genotyping. For each variety showing resistance, the nature of the resistance (ASR or APR) is indicated based on the current occurrence (presence/absence, frequency) and distribution of pathogen virulence. As our knowledge of APR genes in Australian cereal varieties improves, it will be possible to provide more detailed information regarding the genetic basis of APR in varieties and the level of protection the genes confer.

Disease response categories are summarized in **Table 1**. The colour coding in this table has been used in all tables to assist in highlighting strengths and potential weaknesses in varieties with respect to the three rust diseases.

The rust responses of current Australian common wheat, durum wheat and triticale varieties are provided in three sections, the first being for common wheat, the second for durum wheat, and the third triticale. Within each

section there are two to three tables: the first comprises varieties for which NVT consensus ratings were assigned in 2019; additional tables comprise older varieties that while not included in the 2019 NVT testing have been assessed for rust response in the past, or very recent releases for which consensus field rust response ratings are not yet available.

All Stage Resistance (ASR) versus Adult Plant Resistance (APR)

Resistance to rust pathogens in cereals can be expressed at all growth stages from primary leaf emergence onwards (All Stage Resistance (ASR), aka seedling resistance, major gene resistance), or at post seedling growth stages only (Adult Plant Resistance (APR), aka minor gene resistance). Genes conferring both types of resistance occur in Australian wheat, barley and triticale varieties- some varieties carry ASR or APR, others carry both. The identities and effectiveness of most if not all of the ASR genes present in Australian wheat, barley and triticale varieties are well understood. Research on the genetic basis of rust resistance in wheat and barley over the past 25 years has greatly improved our understanding of the genes present that confer APR; these studies have also shown that there are other genes conferring APR that while still uncharacterized are important in protecting against rust infection and hence yield loss. Research by the Australian Cereal Rust Control Program has permitted accurate determination of the presence/absence of the following APR genes in Australian wheat varieties: *Lr34/Yr18/Sr57*, *Lr46/Yr29/Sr58*, *Lr67/Yr46/Sr55* and *Sr2*. Two of these resistances are known to be due to a single gene that confers resistance against all three rust pathogens (*Lr34/Yr18/Sr57* and *Lr67/Yr46/Sr55*), and the resistance *Lr46/Yr29/Sr58* is similarly thought to be due to a single gene. The multiple ASR resistances *Lr37/Yr17/Sr38* and *Lr24/Sr24* each likely comprise separate genes that are inherited as a linkage block due their presence on chromosomal segments that were introgressed into wheat from alien grass species.

Pathotype distribution determines varietal response

Long-term nation-wide annual surveys of the virulence of the cereal attacking rust pathogens have been critical in understanding and predicting the responses of cereal varieties to rust diseases and providing direction for resistance breeding. The separation of the eastern and western Australian cereal belts, the common movement of rusts from west to east, and the less common movement of rusts from east to west, have resulted in some pathotypes (and hence virulences) being restricted to eastern Australia.

At present, there is little difference in the pathotypes of stem rust that occur across Australia, and for this reason a single national stem rust response rating is provided for all varieties.

With stripe rust, virulences for the resistance genes *Yr17*, *Yr27*, *YrJ* (in triticale only) and *YrT* (in triticale only) occur only in eastern Australia. For this reason, separate ratings are provided for each variety for eastern and Western Australia. Virulence for two further resistance genes, *Yr4* and *Yr33*, has been detected in eastern Australia in recent years in the pathotypes 198 E16 A+ J+ T+ 17+ (“198”) and 239 E237 A- 17+ 33+ (“239”), respectively. An additional column has been added to **Table A-1** to indicate the impact, if any, of these pathotypes. It should be noted that while “198” has increased rapidly in frequency in eastern Australia in the 2019 and 2020 seasons, that of “239” has remained very low.

The most significant changes in rust response ratings between eastern and Western Australia in recent years has been due to a series of changes in the pathotypes of wheat leaf rust in Australia and the movement of several pathotypes from the eastern grains belt to WA. Changes to the varietal ratings in the eastern States have been from the occurrence of two new wheat leaf rust pathotypes: 76-3,5,7,9,10,12,13 +Lr37 (2013) and 104-1,3,4,6,7,8,9,10,12 +Lr37 (2014). These pathotypes have introduced virulence combinations that have altered the leaf rust resistance ratings of many varieties. The introduction of three wheat leaf rust pathotypes to Western Australia from the eastern states in 2013 (pathotype 76-1,3,5,7,9,10,12 +Lr37), 2015 (pathotype 104-1,3,4,6,7,8,10,12 +Lr37), and in 2017 (104-1,3,4,5,7,9,10,12 +Lr37) shifted the leaf rust response of many varieties in WA towards increased susceptibility. The primary change in the consensus ratings has been through the introduction of virulences for *Lr13* and *Lr27+31* to Western Australia. Varieties affected include: Chara, Corack, Emu Rock, Mace, Wallup and Wyalkatchem. Pathotype 104-1,3,4,6,7,8,10,12 +Lr37 combines virulence for *Lr13*, *Lr27+31* and *Lr37*, and has rendered varieties carrying one or more of these resistances more susceptible in both eastern Australia and WA.

The complementary ASR leaf rust resistance genes *Lr27+31* have been used in Australian wheat breeding since Gatcher was released in 1969 (Park & McIntosh 1994). In addition to conferring resistance to leaf rust, gene *Lr27* is associated with the durable APR stem rust resistance gene *Sr2* and *Lr31* with the non-durable APR leaf rust resistance gene *Lr12* (Singh et al., 1999). Virulence for *Lr27+31* was first detected in the early 1970s and then became very common, and but was displaced after 1990 by the buildup of an exotic leaf rust pathotype avirulent for this resistance that was

first detected in 1984 (Park et al 1995). We showed that virulence for *Lr27+31* was completely associated with virulence for the APR gene *Lr12*, and that the ASR gene *Lr31* and APR gene *Lr12* are likely one and the same (Singh et al. 1999). Virulence for *Lr27+31* was not detected again until 2014, with the appearance of pathotype 104-1,3,5,6,7,10,12 +Lr37, and is now once again common not only in eastern Australia but also WA.

Virulence for resistance gene *Lr24* was first detected in eastern Australia in 2000 (Park et al. 2002). It has been

detected in all but four years since then. The frequency of virulence for *Lr24* in eastern Australia has remained low since 2015 (less than 7%), and has not been detected to date in 2020, and for this reason a single national rating for leaf rust response that does not take into consideration virulence for *Lr24* was assigned by the 2019 NVT panel. Eastern Australian Growers of all varieties carrying *Lr24* are advised nonetheless to monitor crops for leaf rust closely.

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Rusted Plant Samples

Can be mailed in paper envelopes;
do not use plastic wrapping or plastic lined packages. If possible, include the latitude and longitude of the sample location, date of collection, cultivar, and your full contact details.

Fill in the submission form and direct rust samples to:

University of Sydney
Australian Cereal Rust Survey
Reply Paid 88076
Narellan NSW 2567

The Australian Cereal Rust Control Program is supported by growers through the Grains Research & Development Cooperation.



Table 1 Response descriptors for the rust diseases

Response	Description
R	highly resistant: occasional symptoms of infection including necrotic flecks; no sporulation
RMR	resistant: symptoms evident and usually with necrosis and chlorosis, limited sporulation, and affected leaf area up to 15%
MR	moderately resistant: evidence of sporulating areas on the leaf surface with some chlorosis and necrosis, and affected leaf area up to 30%
MRMS	intermediate: restricted sporulating areas with some chlorosis, and affected leaf area up to 50%
MS	moderately susceptible: freely sporulating lesions and affected leaf area up to 70%
MSS	moderately susceptible to susceptible: freely sporulating lesions with leaf area affected up to 90%
S	susceptible: abundant sporulation across the whole leaf surface; leaf area affected up to 100%; some chlorosis and necrosis evident
SVS	susceptible to very susceptible: abundant sporulation across the leaf surface; leaf area affected up to 100%; limited chlorosis
VS	highly susceptible: abundant sporulation across the whole leaf area with no evidence of chlorosis or necrosis; 100% leaf area affected

SECTION A: LEAF RUST, STEM RUST AND STRIPE RUST RESPONSE AND DISEASE RESISTANCE GENOTYPES OF AUSTRALIAN COMMON WHEAT VARIETIES

Table A-1: Rust responses of common wheat varieties included in 2019 NVT testing

Variety name	Leaf rust				Stem rust				Stripe rust					
	ASR Lr genes*	APR Lr genes*	2019 NVT National Consensus rating	Resistance due to:**	ASR Sr genes	APR Sr genes	2019 NVT National Consensus rating	Resistance due to:**	ASR Yr genes	APR Yr genes	2019 NVT Consensus rating		Resistance due to:**	Response change to new pathotypes (east only)
											Eastern states	WA		
Anapurna	Lr1, Lr3a, Lr17a, Lr37	Lr46	MSP	APR	Sr38	Sr58	MSSp	APR	Yr4, Yr17, Yr27	Yr29	Rp	Rp	APR	No change
B53	Lr14a	?	MSS	APR	Sr8a, Sr9g, Sr30+	-	MSS	ASR (Sr30)	Yr7?	?	MRMS	MR	APR	No change
Beckom	Lr3a, Lr37	Lr34, Lr46	MSS	APR	Sr9b, Sr38	Sr57, Sr58	MRMS	APR	Yr7?, Yr17	Yr18, Yr29	MRMS	MR	APR	No change
Borlaug 100	Lr27+31, Lr37	?	MR	APR	Sr9b, Sr38	-	MR	APR	Yr17, Yr27	?	MSS^	R	APR	S#
Bremer	Lr24, Lr37	?	MR	ASR (Lr23)	Sr24, Sr38	Sr2, Sr57	MR	ASR (Sr24)	Yr6, Yr17, YrA	Yr18	S	MR	None	No change
Buchanan	Lr27+31, Lr37	?	MR	APR	Sr38+	Sr2	MRMS	ASR or APR?	Yr17	?	RMR^	RMR	APR	MRMS##
Catapult	Lr3a, Lr13	Lr46	S	APR	Sr8a, Sr30	Sr58	MR	ASR (Sr30)	Nil	Yr29	MRMS	RMR	APR	No change
Chief CL Plus	Lr20, Lr24	?	MR	APR	Sr15, Sr24	-	MR	ASR (Sr24)	Nil	-	S	S	None	No change
Cobalt	Not tested	?	MS	?	Not tested	-	S	None	Not tested	Not tested	RMR^	RMR	APR	MR##
Condo	Lr3a	Lr34	MSS	APR	Sr9g	Sr57	MR	APR	Yr7, Yr27	Yr18	MSS^	MR	APR	MS##
Coolah	Lr3a, Lr23	Lr34, Lr46	RMR/MS	ASR (Lr23)	Sr8a, Sr30	Sr57, Sr58	MR	ASR (Sr30)	Yr3, Yr33	Yr18, Yr29	RMR	RMR	APR	No change
Corack	Lr3a, Lr13, Lr20 (Het.)	Lr46	SVS	None	Sr8a, Sr30	Sr58	MR	ASR (Sr30)	Nil	Yr29	MS	MS	APR	No change
Cosmick	Lr13, Lr27+31, Lr73	-	SVS	None	Sr8a, Sr30+	Sr2	MS	ASR (Sr30)	Nil	?	MSS^	MSS	APR	MS##
Cutlass	Lr3a, Lr24, Lr37	Lr34, Lr46	R	ASR (Lr24)^	Sr24, Sr38	Sr57, Sr58	R	ASR (Sr24)	Yr17	Yr29	MS	RMR	APR	No change
Devil	Lr3a, Lr13 or 37?	-	SVS	None	Sr8a, Sr9b, Sr30	-	MS	ASR (Sr30)	Nil	?	MS	MR	APR	No change
DS Bennett	Lr13	-	SVS	None	Sr17, Sr30	-	MRMS	ASR (Sr30)	Nil	-	S^	R	None	SVS#
DS Darwin	Lr27+31, Lr37	?	MSS	APR	Sr8a, Sr38?	Hetero	MRMS	APR	Yr4, Yr17	Hetero	MRMS	MR	APR	No change
DS Faraday	Lr3a, Lr27+31	Lr34	R/MS	APR	Sr12, Sr26	Sr57	MR	ASR (Sr12+ Sr26)	Yr3, Yr6, YrA	Yr18	RMR^	RMR	APR	MR##
DS Pascal	Lr13, Lr27+31	?	MS	APR	Sr5, Sr30	-	MSS	ASR (Sr30)	Yr3, Yr6, YrA	?	RMR^	RMR	APR	MR##
DS Tull	Lr1	Lr34	MSS	APR	Sr9g, Sr30	Sr57	MR	ASR (Sr30)	Yr7+	Yr18	RMR	RMR	APR	No change
EGA Gregory	Lr3a, Lr23	Lr34	RMR/MS	ASR (Lr23)	Sr8a, Sr12, Sr30	Sr57	MR	ASR (Sr12+ Sr30)	Yr33	Yr18	MR	MR	APR	No change
EGA Wedgetail	Lr13	Lr34, Lr46	MSS	APR	Sr9g, Sr30	Sr57, Sr58	MRMS	ASR (Sr30)	Yr3, Yr7	Yr18, Yr29	MS	MS	APR	No change
Elmore CL Plus	Lr24+	Lr34	RMR	ASR (Lr24)^	Sr24+	Sr57	MR	ASR (Sr24)	Yr3, Yr7	Yr18	MRMS	MRMS	APR	No change
Emu Rock	Lr13, Lr27+31, Lr73	-	SVS	None	Sr8a, Sr9g, Sr30	Sr2	MS	ASR (Sr30)	Yr4, Yr7	?	MSS	MRMS	APR	No change
Grenade CL Plus	Lr1, Lr37	-	S	None	Sr5, Sr8a, Sr12, Sr38	-	MR	ASR (Sr12)	Yr4, Yr17	?	MRMS	RMR	APR	No change
Harper	Lr1, Lr37, Lr73	-	S	None	Sr9b, Sr12, Sr38	-	MS	ASR (Sr12)	Yr17	?	MS	RMR	APR	No change
Hatchet CL Plus	Lr1, Lr37	-	SVS	None	Sr8a, Sr9g, Sr38	-	MS	APR	Yr4, Yr7, Yr17	?	MSS^	MR	None	S#
Hydra	Lr13, Lr27+31	-	SVS	None	Sr5, Sr11, Sr26	-	MS	ASR (Sr26)	Nil	?	MS	MS	APR	No change
Illabo	Lr27+31, Lr37	-	S	None	Sr9b, Sr38	-	MRMS	APR	Yr17+	?	MRp^	RMR	APR	MRMS#
Impress CL Plus	Lr27+31, Lr24	-	RMR	ASR (Lr24)^	Sr9g, Sr24	Sr2	MR	ASR (Sr24)	Yr6, Yr7	?	MSS	MSS	APR	No change
Jade	Lr13, Lr27+31	?	MSS	APR	Sr6, Sr30	Sr2	MSS	ASR (Sr30)	Yr4	?	RMR	RMR	APR	No change
Kinsei	Lr3a, Lr37+	-	MSS	ASR (?)	Sr6, Sr8a+	-	MSS	APR	Yr3, Yr17	?	MRMS	MRMS	APR	No change
Kiora	Lr14a	Lr34, Lr46	MRMS	APR	Sr30	Sr57, Sr58	MR	ASR (Sr30)	Yr4, Yr27	Yr18, Yr29	RMR^	RMR	APR	MR##
Livingston	Lr1, Lr3a, Lr13, Lr37	Lr34	R/MSS	APR	Sr38+	Sr2, Sr57	MRMS	APR	Yr7, Yr27	Yr18	MRMS	R	APR	No change
Longsword	Lr3a, Lr13, Lr37	Lr46	MSS	APR	Sr30, Sr38	Sr58	MR	ASR (Sr30)	Yr17, Yr27	Yr29	MR	RMR	APR	No change
LRPB Arrow	Lr3a, 13, Lr20	-	SVS	None	Sr8a, Sr9g, Sr15	-	S	None	Nil	-	S	S	None	No change
LRPB Beaufort	Lr13, Lr37	?	MS	APR	Sr6, Sr11, Sr38	-	SVS	None	Yr1, Yr17	?	RMR	RMR	APR	No change
LRPB Cobra	Lr1, Lr3a, Lr13, Lr27+31	?	MR/S	APR	Sr8a, Sr9g, Sr30+	Sr2	MR^	ASR (Sr30)	Yr7	?	MSS^	MSS	APR	MS##
LRPB Dart	Lr1, Lr13	Lr34	S	None	Sr9g, Sr26	Sr57	MR	ASR (Sr26)	Yr7+	Yr18	MR^	MR	APR	MRMS##
LRPB Flanker	Lr3a, Lr23	Lr34	RMR/MSS	ASR (Lr23)	Sr8a, Sr9g, Sr30+	Sr57	MR	ASR (Sr30)	Yr7+	Yr18	RMR	RMR	APR	No change
LRPB Gazelle	Lr24, Lr37	-	RMR	ASR (Lr24)^	Sr24, Sr38	-	MR	ASR (Sr24)	Yr17+	?	MR	RMR	APR	No change
LRPB Havoc	Lr27+31, Lr37	?	MSS	APR	Sr9g, Sr38	-	S	None	Yr7, Yr17+	?	MR^	MR	APR	MRMS##
LRPB Hellfire	Lr1	Lr46	MSS	APR	Sr9g, Sr26	Sr58	MR	ASR (Sr26)	Yr7	Yr29	MR	RMR	APR	No change

LRPB Impala	Lr37	Lr34	SVS	None	Sr5, Sr12, Sr38+	Sr57	MR	ASR (Sr12)	Yr17+	Yr18	MR	MR	APR	No change
LRPB Lancer	Lr24	Lr34	RMR/MS	ASR (Lr24)^	Sr24, Sr36	Sr57	R	ASR (Sr24+ Sr36)	Yr6+	Yr18	MR	MR	APR	No change
LRPB Mustang	Lr37	Lr34	MSS	APR	Sr5, Sr9g, Sr30	Sr57	MRMS	ASR (Sr30)	Yr7+	Yr18	RMR^	RMR	APR	MR##
LRPB Nighthawk	Lr1	Lr34	MSS	APR	Sr5, Sr30	Sr57	RMR	ASR (Sr30)	Yr4	Yr18	RMR	RMR	APR	No change
LRPB Nyala	Lr3a (Het.)	Lr34	S	None	Sr5, Sr38+	Sr57	SVS	None	Yr17+	Yr18	RMR	RMR	APR	No change
LRPB Oryx	Lr24	Lr34	RMR/S	ASR (Lr24)^	Sr24, Sr36	Sr57	MR	ASR (Sr24+ Sr36)	Not tested	Yr18	RMR	RMR	?	No change
LRPB Parakeet	Lr1, Lr24, Lr37	Lr34	R	ASR (Lr24)^	Sr24, Sr36, Sr38	Sr57	MR	ASR (Sr24+ Sr36)	Yr4, Yr17+	Yr18	RMR	RMR	APR	No change
LRPB Reliant	Lr3a, Lr23	Lr34	RMR	ASR (Lr23)	Sr36+	Sr57	R	ASR (Sr36)	Yr33	Yr18	MR	MR	APR	No change
LRPB Spitfire	Lr1	Lr46	MSS	APR	Sr26	Sr2, Sr58	MR	ASR (Sr26)	Yr7	Yr29	MR	MR	APR	No change
LRPB Trojan	Lr23	-	MR/MS	ASR (Lr23)	Sr6, Sr30	Sr2	MRMS	ASR (Sr30)	Nil	?	MSS	MR	APR	No change
Mace	Lr3a, Lr13, Lr20, Lr37	?	MSS	APR	Sr8a, Sr30, Sr38	Sr2	MRMS	ASR (Sr30)	Yr17	-	SVS	RMR	None	No change
Manning	Lr23, Lr26, Lr37	-	MSS	ASR (Lr23)	Sr31, Sr38	-	MR	ASR (Sr31)	Yr9+, Yr17	?	RMR	RMR	APR	No change
Mitch	Lr13, Lr27+31	?	MSS	APR	Sr9g, Sr30	Sr2	MRMS	ASR (Sr30)	Nil	?	MR	MR	APR	No change
Ninja	Lr3a, Lr13 or 37+	-	S	None	Sr9b	-	SVS	None	Yr7	?	MS	MS	APR	No change
Razor CL Plus	Lr3a, Lr37	Lr46	S	None	Sr8a or 9b, Sr38	Sr58	MRMS	APR	Yr17	Yr29	MS	RMR	APR	No change
RGT Accroc	Lr13	-	SVS	None	Sr8a, Sr9g	-	MS	APR	Yr7+	?	R^	R	APR	RMR##
RGT Calabro	Lr37	?	MSS	APR	Sr8a or 9b, Sr38	-	MS	APR	Yr7, Yr17	?	RMR	RMR	APR	No change
RGT Zanzibar	Lr37	-	SVS	None	Sr38	-	VS	None	Yr17+	?	R	R	APR	No change
RockStar	Lr3a, Lr20	-	S	None	Sr9g, Sr15, Sr30	-	MR	ASR (Sr30)	Yr7, Yr17	?	MRMS	RMR	APR	No change
Scepter	Lr3a, Lr27+31, Lr37+	Lr46	MSS	APR	Sr8a, Sr9g, Sr38	Sr2, Sr58	MRMS	APR	Yr17+	?	MSS	MR	APR	No change
SEA Condamine	Lr27+31	?	MR	APR	Sr26	-	MRMS	ASR (Sr26)	Nil	?	MRMS	MR	APR	No change
SF Adagio	Lr37	-	S	None	Sr38	-	SVS	None	Yr17	?	RMR	RMR	APR	No change
SF Hekto	Lr3a, Lr37	Lr67	S	None	Sr38	Sr2, Sr55	S	None	Yr17	?	RMR	RMR	APR	No change
SF Ovalo	Lr13	?	MSS	APR	Nil	-	SVS	None	?	?	R^	R	APR	MR##
SF Scenario	Lr37	?	MSS	APR	Sr38	-	MSS	APR or seedling?	Yr17	?	R^	R	APR	RMR#
Sheriff CL Plus	Lr3a, Lr13, Lr20	-	SVS	None	Sr8a, Sr15+	-	MS	APR or seedling?	Nil	?	MSS	MS	APR	No change
SQP Revenue	Lr20, Lr27+31, Lr37	-	VS	None	Sr15, Sr38	-	RMR^	APR	Yr17+	?	R	R	APR	No change
Sunchaser	Lr24, Lr23	Lr34	R	ASR (Lr24)^	Sr24	Sr57	MR	ASR (Sr24 + Sr26)	?	Yr18	MR	MR	APR	No change
Sunguard	Lr13, Lr24	Lr34	RMR	ASR (Lr24)^	Sr24, Sr33	Sr57	R	ASR (Sr24 + Sr33)	Yr6+	Yr18	MR	MR	APR	No change
Sunlamb	Lr37	Lr46	MS	APR	Sr38+	Sr2, Sr58	RMR	ASR (Sr26)	Yr3, Yr17, Yr27	Yr29	MRMS	MR	APR	No change
Sunmate	Lr3a, Lr27+31, Lr37	Lr46	MRMS	APR	Sr30, Sr38	Sr2, Sr58	MRMS	ASR (Sr30)	Yr17, Yr27	Yr29	MRMS	R	APR	No change
Sunmax	Lr1, Lr20, Lr27+31, Lr37	Lr46	MS	APR	Sr8a or Sr9b, Sr38	Sr2, Sr58	MR	APR	Yr17+	Yr29	RMR	RMR	APR	No change
Sunprime	Lr13, Lr23	Lr34, Lr46	MR/S	ASR (Lr23)	Sr8a, Sr9g, Sr30	Sr57, Sr58	MRMS	ASR (Sr30)	Yr7	Yr18, Yr29	RMR^	RMR	APR	MR##
Suntime	Lr1, Lr27+31, Lr37	Lr46	MS	APR	Sr8a, Sr30, Sr38	Sr2, Sr58	MRMS	ASR (Sr30)	Yr17	Yr29	RMR^	RMR	APR	MR#
Suntop	Lr3a, Lr27+31, Lr37	?	MR	APR	Sr30, Sr38	Sr2	MRMS	ASR (Sr30)	Yr31	?	MRMS	MR	APR	No change
Sunvale	Lr3a, Lr37	Lr34	MRMS	APR	Sr36, Sr38	Sr57	RMR	ASR (Sr36)	Yr17+	Yr18	MR	MR	APR	No change
Supreme	Lr24, Lr37	-	RMR	ASR (Lr24)^	Sr24, Sr38	Sr2	MRMS	ASR (Sr24)	Yr17	-	SVS	MR	None	No change
Tenfour	Lr37	?	MSS	APR	Sr30, Sr38	Sr2	SVS	ASR (Sr30)	Yr17	-	SVS	MR	None	No change
Tungsten	Lr27+31+	?	MS#	APR	Sr30	-	MS	ASR (Sr30)	Yr33	Yr18	RMR^	RMR	APR	MR#
Vixen	Lr3a, Lr20, Lr37	-	SVS	None	Sr8a, Sr9g, Sr30	-	MRMS	ASR (Sr30)	Yr7+	?	MRMS^	MRMS	APR	MSS##
Wallup	Lr13, Lr20, Lr27+31	-	S	None	Sr8a, Sr15, Sr30	Sr2	MRMS	ASR (Sr30)	Nil	?	MRMS	MRMS	APR	No change
Wyalkatchem	Lr3a, Lr13, Lr20 (Het.)	Lr46 (Het.)	S	None	Sr8a, Sr9g, Sr15 (Het.)	Sr2, Sr58*	MSS	APR	Nil	-	S	S	None	No change
Yitpi	Lr13	-	S	None	Sr30	-	S	ASR (Sr30)	Yr4+	Yr29	MS	MRMS	APR	No change
Zen	Lr3a, Lr20, Lr27+31	-	S	None	Sr8a, Sr15	Sr2	S	None	Nil	?	MRMS	MRMS	APR	No change

* Genes in **bold** face are still effective against all current pathotypes in Australia

** ASR= All Stage Resistance, APR= Adult Plant Resistance

^ indicates the variety may be more susceptible to virulent pathotypes that occur in eastern Australia at a low frequency

+ or ? indicate the presence of an uncharacterised resistance gene

Het indicates a mixed (heterogeneous) response to the disease or for the presence of a resistance gene

P indicates a provisional rating that requires further testing to validate

indicates response to stripe rust pathotype 198 E16 A+ J+ T+ 17+

indicates response to stripe rust pathotype 239 E237 A- 17+ 33+

Table A-2: Rust responses of older common wheat varieties

Variety name	Leaf rust					Stem rust				Stripe rust				
	ASR Lr genes*	APR Lr genes*	Resistance due to:**		ASR Sr genes	APR Sr genes	PBI rating	Resistance due to:**	ASR Yr genes	APR Yr genes	PBI Stripe rust rating		Resistance due to:**	
			Eastern States	WA			National				WA	Eastern states		
Axe	<i>Lr1, Lr3a, Lr13</i>	-	SVS	SVS	None	Sr13	-	MS	Seedling resistance (<i>Sr13</i>)	Yr4	Yr75	RMR	RMR	APR
Calingiri	<i>Lr3a</i>	-	S	MS	APR	<i>Sr6, Sr9g, Sr30</i>	-	S	Seedling resistance (<i>Sr30</i>)	Yr7	-	S	S	None
Chara	<i>Lr13</i>	Lr34	S	S	None	<i>Sr6, Sr8a, Sr9g, Sr30</i>	Sr57	MRMS	Seedling resistance (<i>Sr30</i>)	Yr7+	Yr18	MSS	MSS	APR
Correll	<i>Lr13, Lr37+</i>	-	MSS	MSS	Seedling resistance (?)	Sr30, Sr38	-	MS	Seedling resistance (<i>Sr30</i>)	Yr3, Yr17	-	MSS	MSS	APR
Derrimut	<i>Lr13, Lr20, Lr27+31, Lr37</i>	Lr34	MSS	MSS	APR	<i>Sr15, Sr30, Sr38</i>	Sr2, Sr57	MR	Seedling resistance (<i>Sr30</i>)	Yr17	Yr18	RMR	MSS	APR
EGA Bounty	<i>Lr1, Lr27+31</i>	-	R	R	APR	<i>Sr9g, Sr30</i>	Sr2		Seedling resistance (<i>Sr30</i>)	Yr4, Yr7	Hetero	MR	MR	APR
EGA Kidman	<i>Lr3a, Lr13, Lr23</i>	Lr34	R	R	Seedling resistance (<i>Lr23</i>)	<i>Sr8a, Sr12, Sr9g, Sr30</i>	Sr57		Seedling resistance (<i>Sr12+ Sr30</i>)	Yr3, Yr6, Yr7	Yr18	MRMS	MRMS	APR
Espada	<i>Lr20, Lr24, Lr37</i>	-	R	R	Seedling resistance (<i>Lr24</i>)^	<i>Sr9g, Sr24, Sr38</i>	-	R	Seedling resistance (<i>Sr24</i>)	Yr7, Yr17	-	R	MRMS	APR
Estoc	<i>Lr1, Lr20*, Lr37</i>	-	MRMS	MRMS	APR	<i>Sr8a, Sr12, Sr9g, Sr38</i>	-	MR	Seedling resistance (<i>Sr12</i>)	Yr7, Yr17+	-	MR	MRMS	APR
Forrest	<i>Lr1, Lr13</i>	Lr34	MS	MR	APR	<i>Sr8a, Sr12, Sr30</i>	Sr57	RMR	Seedling resistance (<i>Sr12+ Sr30</i>)	Yr4, Yr6, YrA	Yr18	RMR	RMR	APR
Hartog	<i>Lr1, Lr27+31</i>	-	MR	MR	APR	<i>Sr6, Sr8a, Sr9g, Sr12, Sr30</i>	Sr2, Sr58	MR	Seedling resistance (<i>Sr30</i>)	Yr6, Yr7	-	MS	MS	APR
Janz	Lr24	Lr34	MRMS	MRMS	APR	<i>Sr5, Sr12, Sr24</i>	Sr57	RMR	Seedling resistance (<i>Sr12+ Sr24</i>)	Nil	Yr18	MS	MS	APR
Justica CL Plus	<i>Lr1, Lr3a, Lr37</i>	-	S	MS	None	<i>Sr8a, Sr30, Sr38</i>	-	MR	Seedling resistance (<i>Sr30</i>)	Yr4, Yr17	-	RMR	MS	APR
Kord CL Plus	<i>Lr1, Lr37</i>	-	MS	MRMS	APR	<i>Sr8a, Sr38</i>	-	MR	APR	Yr4, Yr17	-	MR	MRMS	APR
LRPB Gauntlet	<i>Lr3a, Lr37</i>	Lr34	MS	MRMS	APR	<i>Sr8a, Sr26, Sr38</i>	Sr57	RMR	Seedling resistance (<i>Sr26</i>)	Yr6, Yr17	Yr18	RMR	MRMS	APR
LRPB Scout	<i>Lr1, Lr37</i>	-	MS	R	APR	<i>Sr8a or 9b, Sr38</i>	-	MR	APR	Yr4, Yr17	-	RMR	MS	APR
Magenta	<i>Lr1, Lr24</i>	-	MRMS	MRMS	Seedling resistance (<i>Lr24</i>)^	Sr24	-	RMR	Seedling resistance (<i>Sr24</i>)	Yr7+	-	MS	MS	APR
Merlin	<i>Lr1</i>	-	MS	MS	APR	Sr26	-	MR	Seedling resistance (<i>Sr26</i>)	Yr7	-	MR	MR	APR
Naparoo	<i>Lr13, Lr24</i>	-	S	S	N/A**	Sr24	-	RMR	Seedling resistance (<i>Sr24</i>)	Yr33	-	R	R	APR
Orion	<i>Lr1, Lr20, Lr37</i>	-	R	R	APR	<i>Sr9g, Sr12, Sr15, Sr38</i>	-	MR	Seedling resistance (<i>Sr12</i>)	Yr7, Yr17	-	RMR	MSS	APR
Phantom	<i>Lr3a*, Lr37</i>	-	S	MR	APR	Sr26, Sr38	-	MS	Seedling resistance (<i>Sr26</i>)	Yr17	-	MR	MR	APR
Preston	<i>Lr3a, Lr13, Lr37</i>	-	SVS	MRMS	None	<i>Sr38</i>	-	SVS	None	Yr17, Yr27	-	RMR	RMR	APR
Shield	<i>Lr24, Lr27+31, Lr37</i>	Lr34	R	R	Seedling resistance (<i>Lr24</i>)^	Sr24, Sr38	Sr57	RMR	Seedling resistance (<i>Sr24</i>)	Yr4, Yr17+	Yr18	RMR	MR	APR
Steel	<i>Lr3a+</i>	-	MRMS	MR	APR	<i>Sr17, Sr30</i>	Sr57	MSS	Seedling resistance (<i>Sr30</i>)	Nil	Yr29	RMR	RMR	APR
Strzelecki	<i>Lr13, Lr23</i>	Lr34	R	R	Seedling resistance (<i>Lr23</i>)	<i>Sr8a, Sr9g, Sr30</i>	Sr57		Seedling resistance (<i>Sr30</i>)	Yr33	Yr18	MR	MR	APR
Viking	<i>Lr13</i>	Lr34	MSS	MSS	APR	<i>Sr17, Sr30</i>	Sr57	MRMS	Seedling resistance (<i>Sr30</i>)	Yr4	Yr18	RMR	RMR	APR
Westonia	<i>Lr3a+</i>	-	MSS	MSS	APR	<i>Sr6, Sr9g</i>	-	SVS	None	Yr3, Yr6, Yr7	-	VS	VS	None

* Genes in **bold** face are still effective against all current pathotypes in Australia

** ASR= All Stage Resistance, APR= Adult Plant Resistance

^ indicates the variety may be more susceptible to virulent pathotypes that occur in eastern Australia at a low frequency

+ or ? indicate the presence of an uncharacterised resistance gene

Het indicates a mixed (heterogeneous) response to the disease or for the presence of a resistance gene

Table A-3 Rust genotypes of new common wheat varieties for which consensus field response data are not yet available

Variety name	Leaf rust*		Stem rust*		Stripe rust*	
	ASR Lr genes**	APR Lr genes**	ASR Sr genes	APR Sr genes	ASR Yr genes	APR Yr genes
EG Jet	<i>Lr1, Lr3a, Lr27+31, Lr37</i>	-	<i>Sr38</i>	-	<i>Yr17+</i>	-
EG Titanium	<i>Lr13+</i>	-	<i>Sr9b, Sr30</i>	-	<i>Yr3, Yr7+</i>	-
EGA Eagle Rock	<i>Lr24</i>	-	<i>Sr24</i>	-	Nil	-
Einstein	<i>Lr13</i>	-	Nil	-	<i>Yr3, Yr7</i>	-
LGGold	<i>Lr1, Lr23, Lr13 or 37</i>	-	<i>Sr6, Sr8a, Sr9b</i>	-	<i>Yr4</i>	-
LRPB Kittyhawk	<i>Lr37</i>	<i>Lr34*</i>	<i>Sr5, Sr38</i>	<i>Sr57</i>	<i>Yr17</i>	<i>Yr18</i>
Shark	<i>Lr26</i>	-	<i>Sr31</i>	-	<i>Yr4, Yr9</i>	-
Zircon	??	-	<i>Sr6, Sr30</i>	-	?	-

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+ or ? indicate the presence of an uncharacterised resistance gene

SECTION B: LEAF RUST, STEM RUST AND STRIPE RUST RESPONSE AND DISEASE RESISTANCE GENOTYPES OF AUSTRALIAN DURUM WHEAT VARIETIES

Table B-1: Rust responses of durum wheat varieties included in 2019 NVT testing

Variety name	Leaf rust			Stem rust			Stripe rust		
	ASR Lr genes	2019 NVT consensus National	Resistance due to***:	ASR Sr genes	2019 NVT consensus National	Resistance due to:***	ASR Yr genes	2019 NVT consensus	
								Eastern states	WA
Bitalli	?	MR	ASR	Sr9e+	MR	ASR	Yr4, Yr6+	MS	MR
DBA Artemis	?	RMR	ASR	?	MR^	ASR	Yr7+	MS	RMR
DBA Bindaroi	?	MR	ASR	?	MRMS	ASR	Yr4		
DBA Lillaroi	?	RMR	ASR	?	RMR	ASR	Yr4+	MS	RMR
DBA Spes	?	R	ASR	?	R	ASR	Yr7+	MS	RMR
DBA Vittaroi	?	MR	ASR	Sr9g+	MR	ASR	Yr4	MS	MR
DBA-Aurora	?	R	ASR	Sr9e+	RMR	ASR	Yr7+	MRMS	RMR
EGA Bellaroi	?	RMR	ASR	Sr9g+	MR	ASR	Yr4+	MS	RMR
Jandaroi	?	MRMS	ASR	?	R/MSS	ASR	Yr4, Yr7+	MR	MR
Westcourt	?	RMR	ASR	?		ASR	?	MR	RMR

* Genes in **bold** face are still effective against all current pathotypes in Australia

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+ or ? indicate the presence of an uncharacterised resistance gene

Table B-2: Rust responses of older durum wheat varieties

Variety name	Leaf rust				Stem rust			Stripe rust			
	ASR Lr genes	Eastern states	WA	Resistance due to:***	ASR Sr genes	National	Resistance due to:***	ASR Yr genes	Eastern states	WA	Resistance due to:***
Caparoi	?	RMR	R	ASR	?	R	ASR	Nil	MR	MR	ASR
Hyperno	?	R	RMR	ASR	?	RMR	ASR	Yr4	MR	MR	ASR
Penne	?	R	RMR	ASR	Sr9g+	MR	ASR	?	MR	MR	ASR
Rotini	?	R	RMR	ASR	Sr9g+	RMR	ASR	?	MR	MR	ASR
Tjikuri	?	R	RMR	ASR	Sr9g+	MR	ASR	Yr4	MR	MR	ASR
Yawa	?	R	RMR	ASR	?	RMR	ASR	?	MR	MR	ASR

* Genes in **bold** face are still effective against all current pathotypes in Australia

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+ or ? indicate the presence of an uncharacterised resistance gene

SECTION C: LEAF RUST, STEM RUST AND STRIPE RUST RESPONSE AND DISEASE RESISTANCE GENOTYPES OF AUSTRALIAN TRITICALE VARIETIES

Table C-1: Rust responses of triticale varieties included in 2019 NVT testing

Variety name	Leaf rust			Stem rust			Stripe rust		
	ASR Lr genes*	2019 NVT consensus	Resistance due to:**	ASR Sr genes	2019 NVT consensus	Resistance due to:**	ASR Yr genes	2019 NVT consensus	
		National			National			Eastern states	WA
Astute	?	RMR	ASR	? (+Sr9g?)	RMR	ASR	YrJ &/or YrT	RMR	RMR
Cartwheel	?	R	ASR	SrSatu+	R	ASR	?	R	R
Joey	?	MRp	ASR	SrNin (+Sr9g?)	Sp	ASR	Yr4, YrJ &/or YrT	MRp	MRp
Kokoda	?	RMRp	ASR	SrSatu+	Rp	ASR	?	Rp	Rp
Normandy	?	RMRp	ASR	SrNin+	Rp	ASR	?	Rp	Rp
Wonambi	?	R	ASR	SrNin+ (+Sr9g?)	R	ASR	YrJ &/or YrT	S	MR

* Genes in **bold** face are still effective against all current pathotypes in Australia

** ASR= All Stage Resistance, APR= Adult Plant Resistance

+ or ? indicate the presence of an uncharacterised resistance gene

Table C-2: Rust responses of older triticale varieties

Variety name	Leaf rust				Stem rust			Stripe rust		
	ASR Lr genes*	Eastern states	WA	Resistance due to:**	ASR Sr genes	National	Resistance due to:**	ASR Yr genes	Eastern states	Resistance due to:**
Berkshire	?	R	RMR	ASR	SrNin, SrSatu	R	ASR	Yr4, YrJ &/or YrT	MRMS*	APR
Bison	?	RMR	RMR	ASR	SrNin, SrSatu (+Sr9g?)	RMR	ASR	Yr4, YrJ &/or YrT	R	APR
Canobolas	?	R	RMR	ASR	SrNin, SrSatu (+Sr9g?)	R	ASR	Yr9+	MRMS	APR
Chopper	?	R	R	ASR	SrNin	MR	ASR	Yr9	MRMS	APR
Endeavour	?	R	R	ASR	? (+Sr9g?)	R	ASR	?	RMR	?
Fusion	?	R	R	ASR	SrSatu+	R	ASR	Yr4, YrJ &/or YrT	RMR*	APR
Goanna	?	R	R	ASR	SrNin, SrSatu (+Sr9g?)	R	ASR	YrJ &/or YrT	RMR*	APR
Rufus	?	R	R	ASR		R	ASR		MRMS	?
Tahara	?	R	R	ASR		R	ASR		MRMS	?
Tobruk	?	R	R	ASR		R	ASR		MR	?
Tuckerbox	?	R	R	ASR		MR	ASR		MR	?
Yowie	?	R	R	ASR	SrNin+ (+Sr9g?)	R	ASR	YrJ &/or YrT	MR*	APR

* Genes in **bold** face are still effective against all current pathotypes in Australia

** ASR= All Stage Resistance, APR= Adult Plant Resistance

+ or ? indicate the presence of an uncharacterised resistance gene