

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 2021 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 to explain regional rust response variation, and predict 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 have also provided 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. The current circular also includes updated information on the presence of three ASR genes that are effective only against recently detected rust pathotypes of exotic origins.

Disease response categories are summarized in **Table 1**. The colour coding 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. The tables in each section comprise varieties that were included in the 2021 NVT. Responses of older varieties can be found in

the Cereal Rust Report **17** (3), which we released in September 2020.

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 (Added 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) occurring only in eastern Australia. This has important implications for the rust responses of varieties carrying resistance genes that are overcome by such pathotypes, if grown in the east and the west.

At present, there is little difference in the pathotypes of wheat 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*, *Yr56* (in durum wheats), *YrJ* (in triticale only), *YrT* (in triticale only) occur only in eastern Australia. For this reason, separate ratings are provided for each variety for eastern and Western Australia. Virulences for two further resistance genes, *Yr4* and *Yr33*, were detected in eastern Australia in 2018 and 2017 in the pathotypes 198 E16 A+ J+ T+ 17+ ("198") and 239 E237 A- 17+ 33+ ("239"), respectively.

Both pathotypes 239 and 198 were widespread and reached damaging levels in some wheat crops in eastern Australia in 2020 and 2021. Notwithstanding the favourable conditions for stripe rust development in 2021, the biggest and most confusing aspect for some wheat growers were changes in the responses of some cultivars to stripe rust compared to 2020. Of the 440 pathotype identifications we made of the wheat stripe rust pathogen in 2021, 92% were either the 198 or 239 pathotypes. While these two pathotypes were also the most common in 2020 (80% of the stripe rust isolates identified), the big change in 2021 from 2020 was the increase in the incidence of pathotype 239 - up from just 7% of all identifications in 2020 to 43% in 2021.

Because some varieties are resistant to 198 but susceptible to 239, the increased frequency of the 239 pathotype in 2021 meant that while such varieties displayed resistance in 2020, they were more susceptible in 2021. Examples of this are Catapult, Coolah, LRPB Flanker, Rockstar, and Vixen, which carry resistance genes *Yr25*, *Yr33* or another uncharacterised resistance gene ("*Yr1D*", see below), all of which protect against pathotype 198 but not pathotype 239.

Adding to the confusion is that some varieties are more vulnerable to 198 than they are to 239- for example DS Bennett, LPB Trojan and Borlaug 100, and to a lesser extent Devil, Illabo, DS Darwin, Emu Rock and Hatchet CL Plus. Pathotype 198 is also a greater threat to several durum (eg DBA Artemis, DBA Bindaroi, DBA Lillaroi, DBA Spes, DBA Vittaroi and EGA Bellaroi; **Table 3**) and triticale (Astute, Berkshire, Bison and Joey; **Table 4**).

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 leaf rust 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: Corack, Emu Rock, 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, in the past 2 years has increased somewhat to 22%. A single national rating for leaf rust response that does not take into consideration virulence for *Lr24* was assigned by the 2021 NVT panel. Eastern Australian Growers of all varieties carrying *Lr24* are advised nonetheless to monitor crops for leaf rust closely.

Three “new” ASR rust resistance genes in Australian wheat cultivars

The ability to recognize the presence of an ASR resistance

gene in a variety depends on the presence of a rust pathotype carrying avirulence that matches the resistance gene. Three rust pathotypes of exotic origins detected in recent years carry avirulence for resistance genes that were previously unknown because all existing or older pathotypes were virulent on the genes. Although it sounds counter-intuitive, some varieties that were uniformly susceptible to all pathotypes of a particular rust are now resistant to some pathotypes because of the presence of these genes.

Yr25: This gene was first identified by European researchers in the 1990s. Up until the detection of pathotype 198 in 2018, all Australian pathotypes of the wheat stripe rust pathogen were virulent on this resistance gene so it was not possible to determine its possible presence in Australian wheat varieties. Pathotype 198 was the first detection of avirulence for Yr25 in Australia, and it has allowed us to identify this gene in at least 7 cultivars (**Table 2**) and explain why the resistance of these varieties performed better when pathotype 198 was dominant in 2020.

Yr1D: This is an undesignated ASR gene on chromosome 1D that pathotype 198 is avirulent for but for which all other pathotypes are virulent. We were able to detect the presence of this gene in at least 15 cultivars, some of which are currently grown (**Table 2**). Once again, varieties carrying this gene performed better in 2020 than they did in 2021, because of the dominance of 198 in 2020.

Lr82: This gene was recently mapped and designated by Bariana et al. (2022). It provides protection against pathotypes in the “76” lineage, as well as pathotypes 104-1,3,4,6,7,8,10,12 +Lr37 and 104-1,3,4,5,7,9,10,12 +Lr37. Our rust tests have shown that this gene is present in Correll, EG Titanium, Espada, Orion, Tungsten and Zircon (**Table 2**).

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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.

Direct rust samples to:

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

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



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

TABLE 1: LEAF RUST, STEM RUST AND STRIPE RUST RESPONSE AND DISEASE RESISTANCE GENOTYPES OF AUSTRALIAN COMMON WHEAT VARIETIES INCLUDED IN THE 2021 NATIONAL VARIETY TRIALS

Variety name	Leaf rust				Stem rust				Stripe rust				
	ASR* Lr genes**	APR* Lr genes**	2021 NVT National Consensus rating	Resistance due to:~	ASR* Sr genes**	APR* Sr genes**	2021 NVT National Consensus rating	Resistance due to:~	ASR* Yr genes**	APR* Yr genes**	2021 NVT Consensus rating		Resistance due to:~
											Eastern States	WA	
Anapurna	Lr1, Lr3a, Lr17a, Lr37	Lr46	MS	APR	Sr38	Sr58	MSS	APR	Yr4, Yr17, Yr27	Yr29	RMR	RMR	APR
Ascot	Lr1, Lr3a, Lr37	Lr46	RMR	APR	Sr38	Sr2, Sr58	MRMS	APR	Yr6, Yr17	Yr29	MSS	R	APR
Ballista	Lr3a, Lr13, Lr37	Lr46	S	APR	Sr38	Sr58	MR	APR	Yr17, Yr27	Yr29	MSS	RMR	
Beckom	Lr3a, Lr37	Lr34, Lr46	MSS	APR	Sr9b, Sr38	Sr57, Sr58	MRMS	APR	Yr7?, Yr17	Yr18, Yr29	MRMS	MR	APR
Boree	Not tested	Lr46	S		Not tested	Sr58	MR		Not tested	Yr29	MSS	MR	
Borlaug 100	Lr27+31, Lr37	?	MR	APR	Sr9b, Sr38	-	MR	APR	Yr17, Yr27	?	SVS	R	APR
Calibre	Not tested	Lr46	S		Not tested	Sr58	MR		Not tested	Yr29	MS	RMR	
Catapult	Lr3a, Lr13	Lr46	S	APR	Sr8a, Sr30	Sr58	MR	ASR (Sr30)	Yr25 (Het.)	Yr29	S	RMR	APR
Chief CL Plus	Lr20, Lr24	?	MR	APR	Sr15, Sr24	-	MR	ASR (Sr24)	Nil	-	SVS	S	None
Condo	Lr3a	Lr34	S	APR	Sr9g	Sr57	MR	APR	Yr7, Yr25 (Het.), Yr27	Yr18	MS	MR	APR
Coolah	Lr3a, Lr23	Lr34, Lr46	RMR	ASR (Lr23)	Sr8a, Sr30	Sr57, Sr58	MR	ASR (Sr30)	Yr3, Yr25, Yr33	Yr18, Yr29	MRMS	RMR	APR
Coota	Lr1, Lr13, Lr27+31	Lr46	MS	APR	Sr12, Sr30	Sr2, Sr58	RMR	ASR +APR	Yr6+	Yr29	MS	MR	APR
Corack	Lr3a, Lr13, Lr20 (Het.)	Lr46	SVS	None	Sr8a, Sr30	Sr58	MR	ASR (Sr30)	Nil	Yr29	MSS	MS	APR
Cutlass	Lr3a, Lr24, Lr37	Lr34, Lr46	RMR	ASR (Lr24)*	Sr24, Sr38	Sr57, Sr58	R	ASR (Sr24)	Yr17	Yr29	MSS	RMR	APR
Denison	Lr3a	Lr46	S	None	Sr12, Sr38	Sr2, Sr58	MS	ASR +APR	Yr?, Yr17	Yr29	MSS	MR	APR
Devil	Lr3a, Lr13 or 37?	Lr46	SVS	None	Sr8a, Sr9b, Sr30	Sr58	MS	ASR (Sr30)	Nil	Yr29	S	MR	APR
DS Bennett	Lr13	Lr46	SVS	None	Sr17, Sr30	Sr58	MRMS	ASR (Sr30)	Nil	Yr29	S	R	None
DS Faraday	Lr3a, Lr27+31	Lr34	R#	APR	Sr12, Sr26	Sr57	RMR	ASR (Sr12+ Sr26)	Yr3, Yr6, YrA, Yr1D	Yr18	RMR	MR	APR
DS Pascal	Lr13, Lr27+31	Lr46	MS	APR	Sr5, Sr30	Sr58	MSS	ASR (Sr30)	Yr3, Yr6, Yr25, YrA	Yr29	RMR	RMR	APR
DS Tull	Lr1	Lr34	MSS	APR	Sr9g, Sr30	Sr57	MR	ASR (Sr30)	Yr7+	Yr18	MRMS	RMR	APR
EG Jet	Lr3a, Lr13, Lr37	Lr46	S	None	Sr38	Sr58	S	None	Yr17	Yr29	MRMS	RMR	APR
EG Titanium	Lr27+31, or Lr82	Lr46	MSS	APR	Sr30+?	Sr58	MS	ASR	?	Yr29	MR	RMR	APR
EGA Gregory	Lr3a, Lr23	Lr34	RMR#	ASR (Lr23)	Sr8a, Sr12, Sr30	Sr57	MR	ASR (Sr12+ Sr30)	Yr33, Yr1D	Yr18	MR	MR	APR
EGA Wedgetail	Lr13	Lr34, Lr46	MSS	APR	Sr9g, Sr30	Sr57, Sr58	MRMS	ASR (Sr30)	Yr3, Yr7	Yr18, Yr29	MS	MS	APR
Elmore CL Plus	Lr24+	Lr34	RMR	ASR (Lr24)*	Sr24+	Sr57	MR	ASR (Sr24)	Yr3, Yr7, Yr1D	Yr18	MR	MRMS	APR
Emu Rock	Lr13, Lr27+31, Lr73	Lr46	SVS	None	Sr8a, Sr9g, Sr30	Sr2, Sr58	MS	ASR (Sr30)	Yr7+	Yr29	SVS	MRMS	APR
Grenade CL Plus	Lr1, Lr37	Lr46	S	None	Sr5, Sr8a, Sr12, Sr38	Sr58	MR	ASR (Sr12)	Yr17+	Yr29	MRMS	RMR	APR
Hammer CL Plus	Lr3a, Lr13, Lr37	Lr46	S	None	Sr38+	Sr2, Sr58	MR	APR	Yr17	Yr29	MS	RMR	APR
Illabo	Lr27+31, Lr37	Lr46	S	None	Sr9b, Sr38	Sr58	MRMS	APR	Yr17+	Yr29	MRMS	RMR	APR
Kinsei	Lr3a, Lr37+	-	MSS	ASR (?)	Sr6, Sr8a+	-	MSS	APR	Yr3, Yr17	?	MSS	MRMS	APR
LG Gold	Lr1, Lr3a, +?	Lr46	S	None	Nil	Sr58	MSS	APR	Yr3	Yr29	SVS	RMR	None
Longsword	Lr3a, Lr13, Lr37	Lr46	MR#	APR	Sr30, Sr38	Sr58	MR	ASR (Sr30)	Yr17, Yr27	Yr29	R/S	RMR	APR
LRPB Beaufort	Lr13, Lr37	Lr46	S	APR	Sr6, Sr11, Sr38	Sr58	SVS	None	Yr1, Yr17	Yr29	RMR	RMR	APR
LRPB Cobra	Lr1, Lr3a, Lr13, Lr27+31	Lr46	MR#	APR	Sr8a, Sr9g, Sr30+	Sr2, Sr58	MR	ASR (Sr30)	Yr7	Yr29	MSS	MSS	APR
LRPB Flanker	Lr3a, Lr23	Lr34	RMR#	ASR (Lr23)	Sr8a, Sr9g, Sr30+	Sr57	RMR	ASR (Sr30)	Yr7, Yr1D	Yr18	MR	RMR	APR
LRPB Havoc	Lr27+31+	?	S	APR	Sr9g, Sr30?	-	S	None	Yr7,+	?	MRMS	MR	APR
LRPB Hellfire	Lr1	Lr46	MSS	APR	Sr9g, Sr26	Sr58	MR	ASR (Sr26)	Yr7	Yr29	MR	RMR	APR
LRPB Impala	Lr37	Lr34	SVS	None	Sr5, Sr12, Sr38+	Sr57	MR	ASR (Sr12)	Yr17+	Yr18	MRMS	MR	APR
LRPB Kittyhawk	Lr13, Lr37	Lr34	MR	APR	Sr38	Sr57	MRMS(S)	APR	Yr3, Yr7, Yr17	Yr18	MR	RMR	APR
LRPB Lancer	Lr24	Lr34	RMR#	ASR (Lr24)*	Sr24, Sr36	Sr57	R	ASR (Sr24+ Sr36)	Yr6, Yr1D (Het.)	Yr18	RMR	RMR	APR
LRPB Mustang	Lr37	Lr34	MSS	APR	Sr5, Sr9g, Sr30	Sr57	MRMS	ASR (Sr30)	Yr7, Yr1D	Yr18	RMR	RMR	APR
LRPB Nighthawk	Lr1	Lr34	MSS	APR	Sr5, Sr30	Sr57	RMR	ASR (Sr30)	?	Yr18	MRMS	RMR	APR
LRPB Nyala	Lr3a (Het.)	Lr34	S	None	Sr5, Sr38+	Sr57	SVS	None	Yr17+	Yr18	MRMS	RMR	APR
LRPB Orion	Lr1, Lr13, Lr24, Lr37	Lr46	R	ASR (Lr24)*	Sr24, Sr38	Sr58	MR	ASR (Sr24)	Yr17	Yr29	MS	MR	APR
LRPB Oryx	Lr24	Lr34	RMR#	ASR (Lr24)*	Sr24, Sr36	Sr57	MR	ASR (Sr24+ Sr36)	Not tested	Yr18	MS	RMR	

LRPB Parakeet	Lr1, Lr24, Lr37	Lr34	R	ASR (Lr24)*	Sr24, Sr36, Sr38	Sr57	MR	ASR (Sr24+ Sr36)	Yr17+	Yr18	RMR	RMR	APR
LRPB Raider	Not tested	Lr34	R#	APR	Not tested	Sr57	R		Not tested	Yr18	RMR	RMR	
LRPB Reliant	Lr3a, Lr23	Lr34	RMR	ASR (Lr23)	Sr36+	Sr57	R	ASR (Sr36)	Yr33	Yr18	MR	RMR	APR
LRPB Spitfire	Lr1	Lr46	S	APR	Sr26	Sr2, Sr58	MR	ASR (Sr26)	Yr7	Yr29	MR	MR	APR
LRPB Stealth	Lr24	Lr34, Lr46	RMR#	ASR (Lr24)*	Sr24	Sr2, Sr57, Sr58	R	ASR (Sr24)	?	Yr18, Yr29	RMR	RMR	APR
LRPB Trojan	Lr23	Lr46	MR#	ASR (Lr23)	Sr6, Sr30	Sr2, Sr58	MRMS	ASR (Sr30)	Nil	Yr29	SVS	MR	APR
Manning	Lr23, Lr26, Lr37	-	MSS	ASR (Lr23)	Sr31, Sr38	-	MR	ASR (Sr31)	Yr9, Yr17, Yr1D	?	RMR	RMR	APR
Mitch	Lr13, Lr27+31	Lr46	MSS	APR	Sr9g, Sr30	Sr2, Sr58	MRMS	ASR (Sr30)	Nil	Yr29	MRMS	MR	APR
Razor CL Plus	Lr3a, Lr37	Lr46	S	None	Sr8a or 9b, Sr38	Sr58	MR	APR	Yr17	Yr29	MS	RMR	APR
RGT Accroc	Lr13	Lr46	SVS	None	Sr8a, Sr9g	Sr58	MS	APR	Yr7+	Yr29	RMR	R	APR
RGT Calabro	Lr37	Lr46	MSS	APR	Sr8a or 9b, Sr38	Sr58	MS	APR	Yr7, Yr17	Yr29	RMR	RMR	APR
RGT Cesario	Lr13, Lr24, Lr37?	Lr46	RMRp	ASR (Lr24)*	Sr24	Sr58	R	ASR (Sr24)	Yr7+	Yr29	RMR	R	APR
RGT Ivory	Lr28	-	MR#	ASR (Lr28)*	Nil	-	SVS	None	Yr8??	?	MR	MR	APR
RGT Zanzibar	Lr37	-	SVS	None	Sr38	-	VS	None	Yr17+	?	RMR	R	APR
RockStar	Lr3a, Lr20	Lr46	S	None	Sr9g, Sr15, Sr30	Sr58	MR	ASR (Sr30)	Yr7, Yr17, Yr25	Yr29	S	RMR	APR
Scepter	Lr3a, Lr27+31, Lr37+	Lr46	MSS	APR	Sr8a, Sr9g, Sr38	Sr2, Sr58	MRMS	APR	Yr17, Yr25	Yr29	MSS	MR	APR
SEA Condamine	Lr27+31	Lr46	RMR#	APR	Sr26	Sr58	MRMS	ASR (Sr26)	Nil	Yr29	MS	MR	APR
Severn	Lr13, Lr37	Lr46	MS	APR	Sr38+?	Sr58	MS	APR	Yr17	Yr29	RMRp	RMRp	APR
Sheriff CL Plus	Lr3a, Lr13, Lr20	Lr46	SVS	None	Sr8a, Sr15+	Sr58	MS	APR or seedling?	Nil	Yr29	S	MS	APR
SQP Revenue	Lr20, Lr27+31, Lr37	Lr46	VS	None	Sr15, Sr38	Sr58	RMR	APR	Yr17+	Yr29	RMR	R	APR
Sting	Lr3a, Lr13, Lr37	Lr46	SVS	None	Sr38	Sr58	MRMS	APR	Yr17	Yr29	S	MR	None
Sunblade CL Plus	Lr1, Lr3a, Lr27+31, Lr37	-	MSS	APR	Sr5, Sr38	Sr2	MS	APR	Yr17	-	MRMS	MR	APR
Suncentral	Lr1, Lr3a, Lr13, Lr27+31	Lr46	RMR	APR	Sr30	Sr2, Sr58	MRMS	ASR (Sr30) + APR	?	Yr29	MS	MR	APR
Sunchaser	Lr24, Lr23	Lr34	R	ASR (Lr24)*	Sr24	Sr57	MR	ASR (Sr24 + Sr26)	?	Yr18	RMR	RMR	APR
Sunflex	Lr3a, Lr27+31, Lr37	Lr46	RMR/S	ASR	Sr38	Sr2, Sr58	MR	APR	Yr17, Yr27?	Yr29	RMR	RMR	APR
Sunlamb	Lr37	Lr46	MRMS	APR	Sr38+	Sr2, Sr58	RMR	ASR (Sr26)	Yr3, Yr17, Yr27	Yr29	MR	MR	APR
Sunmaster	Lr3a, Lr27+31, Lr37	-	RMR#	APR	Sr38	-	MS	APR	Yr17	-	MRMS	MR	APR
Sunmate	Lr3a, Lr27+31, Lr37	Lr46	MR	APR	Sr30, Sr38	Sr2, Sr58	MRMS	ASR (Sr30)	Yr17, Yr27	Yr29	MR	R	APR
Sunmax	Lr1, Lr20, Lr27+31, Lr37	Lr46	MS	APR	Sr8a or Sr9b, Sr38	Sr2, Sr58	MRMS	APR	Yr15, Yr17+	Yr29	RMR	RMR	ASR
Sunprime	Lr13, Lr23	Lr34, Lr46	MR#	ASR (Lr23)	Sr8a, Sr9g, Sr30	Sr57, Sr58	MRMS	ASR (Sr30)	Yr7, Yr1D	Yr18, Yr29	RMR	RMR	APR
Suntime	Lr1, Lr27+31, Lr37	Lr46	MS	APR	Sr8a, Sr30, Sr38	Sr2, Sr58	MS	ASR (Sr30)	Yr17	Yr29	MR	RMR	APR
Suntop	Lr3a, Lr27+31, Lr37	?	MR	APR	Sr30, Sr38	Sr2	MRMS	ASR (Sr30)	Yr31	?	MRMS	MR	APR
Tungsten	Lr27+31, Lr82	?	MS#	ASR (Lr82)*	Sr30	-	MS	ASR (Sr30)	Yr33	Yr18	RMR	RMR	APR
Valiant CL Plus	Lr3a, Lr37	Lr46	S	None	Sr38+?	Sr58	MR	ASR	Yr3, Yr17	Yr29	MSS	RMR	APR
Vixen	Lr3a, Lr20+	Lr46	SVS	None	Sr8a, Sr9g, Sr30	Sr58	MRMS	ASR (Sr30)	Yr7+	Yr29	S	MRMS	APR
Wyalkatchem	Lr3a, Lr13, Lr20 (Het.)	Lr46(H)	S	None	Sr8a, Sr9g, Sr15 (Het.)	Sr2, Sr58*	MSS	APR	Nil	Yr29	VS	S	None
Yitpi	Nil	Lr46	S	None	Nil	Sr58	S	ASR (Sr30)	Nil	Yr29	S	MRMS	APR

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

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

~ Indicates what the major component of the resistance of a cultivar is due to. NB in most cases where effective ASR and APR occur together, both resistances will contribute to the cultivar response.

/ Indicates alternate responses to different pathotypes. Mostly used when a cultivar may be more susceptible to a rare pathotype

+ 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

Used as a warning, used when the response to a new or rare pathotype is unknown

TABLE 2: LEAF RUST, STEM RUST AND STRIPE RUST RESPONSE AND DISEASE RESISTANCE GENOTYPES OF AUSTRALIAN DURUM WHEAT VARIETIES INCLUDED IN THE 2021 NATIONAL VARIETY TRIALS

Variety name	Leaf rust			Stem rust			Stripe rust		
	ASR* Lr genes**	2021 NVT consensus	Resistance	ASR* Sr genes**	2021 NVT consensus	Resistance	ASR* Yr genes**	2021 NVT consensus	
		National	due to~:		National	due to:~		Eastern states	WA
Bitalli	?	MR	ASR	<i>Sr9e+</i>	RMR	ASR	<i>Yr4, Yr6, Yr56</i>	MRMS	MR
Caparoi	?	RMR	ASR	?	MR	ASR	<i>Yr56</i>	MS	MR
DBA Artemis	?	RMR	ASR	?	MR	ASR	<i>Yr7, Yr56</i>	MR	RMR
DBA Bindaroi	?	MR	ASR	?	MRMS	ASR	<i>Yr4, Yr56</i>	MS	RMR
DBA Lillaroi	?	RMR	ASR	?	RMR	ASR	<i>Yr4, Yr56</i>	MS	RMR
DBA Mataroi	?	MR	ASR	?	MR	ASR	?	MR	RMR
DBA Spes	?	R	ASR	?	R	ASR	<i>Yr7, Yr56</i>	MS	RMR
DBA Vittaroi	?	RMR	ASR	<i>Sr9g+</i>	MR	ASR	<i>Yr4, Yr56</i>	MS	MR
DBA Aurora	?	R	ASR	<i>Sr9e+</i>	RMR	ASR	<i>Yr7, Yr56</i>	MRMS	RMR
EGA Bellaroi	?	RMR	ASR	<i>Sr9g+</i>	MR	ASR	<i>Yr4, Yr56</i>	MS	RMR
Jandaroi	?	MRMS	ASR	?	R/MSS	ASR	<i>Yr4, Yr7+</i>	MR	MR
Westcourt	?	RMR	ASR	?	RMR	ASR	?	MR	RMR

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TABLE 3: LEAF RUST, STEM RUST AND STRIPE RUST RESPONSE AND DISEASE RESISTANCE GENOTYPES OF AUSTRALIAN TRITICALE VARIETIES INCLUDED IN THE 2021 NATIONAL VARIETY TRIALS

Variety name	Leaf rust			Stem rust			Stripe rust			
	ASR* Lr genes**	2021 NVT consensus National	Resistance due to:~	ASR* Sr genes**	2021 NVT consensus National	Resistance due to:~	ASR* Yr genes**	2021 NVT consensus		Resistance due to:~
								Eastern states	WA	
Astute	?	RMR	ASR	? (+Sr9g?)	RMR	ASR	YrJ &/or YrT	MSS	RMR	APR (ES) or ASR (WA)
Cartwheel	?	R	ASR	SrSatu+	R	ASR	?	RMR	R	ASR
Fusion	?	R	ASR	SrSatu+	R	ASR	Yr4, YrJ &/or YrT	S	RMR	ASR (WA)
Goanna	?	RMR	ASR	SrNin, SrSatu (+Sr9g?)	R	ASR	YrJ &/or YrT	SVS	RMR	ASR (WA)
Joey	?	RMR	ASR	SrNin (+Sr9g?)	S	ASR	Yr4, YrJ &/or YrT	MSS	MR	APR (ES) or ASR (WA)
KM10	?	MR/Sp		?	R		?	S	MR	ASR (WA)
Kokoda	?	RMR	ASR	SrSatu+	R	ASR	?	RMR#	R	ASR
Normandy	?	RMR	ASR	SrNin+	R	ASR	?	RMR	R	ASR
Wonambi	?	R	ASR	SrNin+ (+Sr9g?)	R	ASR	YrJ &/or YrT	S	MR	ASR (WA)

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