Office Use Only	
Project Code	
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FINAL REPORT 2018

PROJECT CODE :	**S517**

PROJECT TITLE
Further development of crown rot resistance in durums

PROJECT DURATION

Project Start date	1 July 2017					
Project End date	30 June 2018					
SAGIT Funding Request	2015/16		2016/17		2017/18	

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PROJECT REPORT

Executive Summary

Durum lines with resistance to crown rot and yield comparable to commercial cultivars have been identified.

The best 17 of these lines are undergoing further yield evaluation in the University of Adelaide durum breeding program at 4 sites in 2018. One line, 1476-067, is in yield trials at 8 sites in 2018. Five lines are in yield trials with and without crown rot in SAGIT project DGA116.

The durum lines have good quality characteristics although a question mark hangs over their dough stability. Testing of 1476-067 by San Remo after the 2018 harvest will resolve whether this is a limiting issue.

New durum lines are being developed that should improve yield and reduce any quality problems. These are being evaluated for crown rot resistance in a new SAGIT project S118 in 2018.

Durum lines with much higher levels of resistance have been developed but the yield of these is too low at present. Crosses to improve the yield of this germplasm have been made and populations are under development and will be ready for initial evaluation in 2019.

Project Objectives

- To develop crown resistance into well adapted, high yielding durums with good quality characteristics. This should enable durums to be grown over a wider area and more intensively in the rotation in current areas of production.
- To provide adapted durum lines for testing in SAGIT project DGA116.

- This project aimed to develop a new generation of durum lines and new crosses in anticipation of future funding from GRDC from 2018.

Overall Performance

The project achieved its objectives through the identification of a number of lines which continued to show good resistance to crown rot on the terraces and which showed high yields comparable to commercial varieties in trials run by Jason Able in the University of Adelaide and by Marg Evans in SARDI in SAGIT project DGA116.

New populations were developed and new crosses made which are undergoing further development in a new SAGIT project S118. These developments were made with the support of technical staff Mark Butt and Greg Naglis of SARDI.

Full quality analysis on 12 lines conducted by Mike Sissons in NSW Agriculture indicated that the quality of 10 of these lines was good with the exception that 11 of them lacked dough stability to varying degrees. How critical this will be is as yet uncertain.

Despite this, one line 1476-067, has been put into S4 yield trials at 8 sites by Jason Able and a further 17 lines included in S3 yield trials at 4 sites in SA. 1476-067 has also been included in a variety trial at the Hart site. Pasta making tests of this line by San Remo in early 2019 should resolve the issue of its quality suitability.

Five of the lines were identified for inclusion in trials in SAGIT project DGA116 based on resistance, yield and quality.

The anticipated resumption of GRDC funding did not eventuate. All GRDC funding for durum crown rot resistance breeding work has been put on hold whilst yield loss studies are undertaken.

Key Performance Indicators (KPI)

KPI	*Achieved (Y/N)*	*If not achieved, please state reason.*
Durum lines will be identified that carry good resistance to crown rot following screening on the Terraces at the Waite in 2017. Report: In 2017 we tested 44 advanced lines on the terraces that were selected from the 2016 season screening based on crown rot resistance, yield and NIR quality testing. The results showed that the resistance detected in earlier years held up well in most lines. Also tested on the terraces were 10 lines derived from the bread wheat known as 2-49 which is rated	Y	

MR to CR. Nine of these lines showed very good resistance as in previous years. They are however poorly adapted compared to the other advanced lines and yield 50% or less than commercial checks. The best of the lines are being used for new crosses to raise the resistance levels in better adapted backgrounds. Tested on the terraces for the first time in 2017 was a single rep of 494 new F6 lines based on crosses with two of the above advanced lines. 30 of these lines showed good resistance and plant type and will be more fully evaluated in 2018. 14 NVT and 12 advanced lines from the University of Adelaide Breeding Program were also screened on the Terraces. None of these appeared to carry any notable resistance.		
New durum lines will be developed and ready for screening on the terraces in 2018 after being grown in the SARDI glasshouses over 3 generations. Report: 330 new F5 lines derived from a two lines based on the bread wheat Kukri and the durum WID902 and crossed into a UA advanced line have been sown on the terraces in 2018. These are likely to have better quality than the earlier lines based on the performance of the parents.	Y	
Lines with good resistance and yield potential will be multiplied and made available to the UA Breeding program and to SAGIT project DGA116 for agronomic evaluation in 2018. Report: 12 lines that had performed very well in 2016 were multiplied at Turretfield in 2017. The lines were carefully rogued for any off types and harvested as pure seed in December. Between 10 and 15 kg were collected for each line. These were catechol tested to remove any bread wheat. Five of these lines were selected for field trial evaluation in DGA116. These and a further 12 lines were included in UA program S3 trials in 2018. One of the lines in UA S3 trials in 2017 will be sown in the S4 trials of the UA breeding program in 2018 and is also being multiplied for possible entry in NVT in 2019.	Y	

Technical Information

In the table below are shown the results of the screening of the most advanced lines in the SAGIT project and these are compared to the results of check varieties and NVT lines. Each score is based on the browning/rotting of the lower stems of 25 plants.

Durum terrace screening 2017

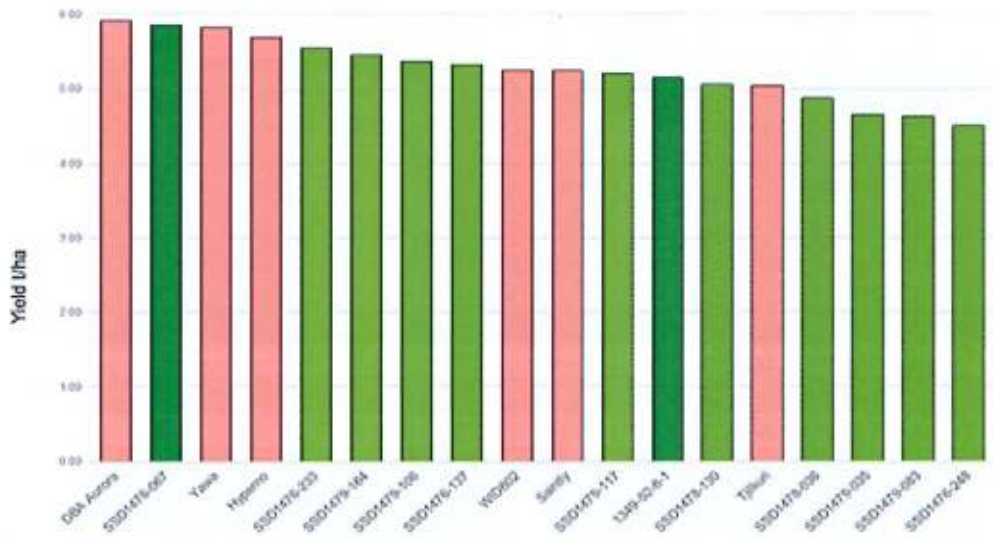
Score < 3.0
Score < Trojan

Checks	Pedigree	Rep 1	Rep 2	Rep 3	Rep 4	Mean 1-5 scale	2018 trial
DBA Aurora	Variety check	4.15	4.23	4.18	4.09	**4.16**	
DBA Lillaroi	Variety check	3.76	4.45	4.56	3.56	**4.08**	
Hyperno	Variety check	4.04	3.52	3.91	3.84	**3.83**	
Tamaroi	Variety check	4.10	3.65	3.83	4.05	**3.91**	
WID802	Variety check	3.76	4.10	3.20	4.63	**3.92**	
WID902	Durum res donor	3.29	3.42	3.62	3.30	**3.41**	
2-49	Bread wheat MR	1.67	2.86	3.17	2.86	**2.64**	
Trojan	Bread wheat MS	2.77	3.50	3.71	2.94	**3.23**	
Sunco	Bread wheat MS	3.41	4.10	4.05	2.74	**3.57**	
NVT lines							
AGTD043		4.00	4.18	3.80	4.10	**4.02**	
190873		3.78	4.25	4.04	3.67	**3.94**	
280913		3.74	4.05	4.00	3.71	**3.87**	
TD1601		3.74	3.77	3.38	3.73	**3.66**	
TD1602		3.63	3.76	4.18	3.78	**3.84**	
SMDU15-018		4.36	3.63	4.00	3.73	**3.93**	
UAD1152076		4.10	3.82	3.83	3.87	**3.90**	
UAD1154192		3.63	3.96	3.90	3.57	**3.76**	
UAD1154197		3.14	3.88	4.22	3.86	**3.77**	
SAGIT lines							
1349-52-5-2	1120C10b-1*WD902	3.20	3.39	2.82	2.86	**3.07**	S3 new
1349-52-8-1	1120C10b-1*WD902	2.83	2.42	3.63	3.05	**2.98**	S3
1351-50-2	1158A3-1*WID902	2.70	4.91	3.05	2.83	**3.37**	
1351-56-5-B	1158A3-1*WID902	3.09	3.28	3.18	3.68	**3.31**	
1351-56-7-B	1158A3-1*WID902	3.12	3.68	3.50	3.25	**3.39**	
SSD1476-023	1051/7/7*WID902	2.75	3.44	3.38	3.09	**3.17**	S3 new
SSD1476-029	1051/7/7*WID902	2.87	3.43	3.04	3.13	**3.12**	
SSD1476-067	1051/7/7*WID902	2.55	3.58	3.10	3.09	**3.08**	**S4 trial**
SSD1476-088	1051/7/7*WID902	3.85	2.87	3.29	2.86	**3.22**	S3 new
SSD1476-137	1051/7/7*WID902	3.60	2.96	3.00	2.57	**3.03**	S3
SSD1476-220	1051/7/7*WID902	3.00	3.24	2.80	3.14	**3.05**	
SSD1476-233	1051/7/7*WID902	3.21	3.23	3.00	2.57	**3.00**	S3
SSD1476-248	1051/7/7*WID902	3.61	3.55	2.38	2.09	**2.91**	S3
SSD1478-001	1206-1/1/2/3*WID902	3.50	3.39	3.68	3.04	**3.40**	
SSD1478-036	1206-1/1/2/3*WID902	3.14	2.74	3.25	3.00	**3.03**	S3
SSD1478-055	1206-1/1/2/3*WID902	3.17	3.52	4.09	2.82	**3.40**	
SSD1478-084	1206-1/1/2/3*WID902	2.62	3.45	3.30	2.65	**3.01**	S3 new
SSD1478-104	1206-1/1/2/3*WID902	2.58	3.57	2.88	3.59	**3.15**	
SSD1478-130	1206-1/1/2/3*WID902	2.77	3.35	3.17	3.39	**3.17**	S3
SSD1478-135	1206-1/1/2/3*WID902	2.96	3.39	2.41	3.13	**2.97**	

SSD1478-137	1206-1/1/2/3*WID902	3.13	3.87	3.15	2.73	**3.22**	
SSD1478-158	1206-1/1/2/3*WID902	3.22	3.32	2.50	2.27	**2.82**	
SSD1478-159	1206-1/1/2/3*WID902	2.48	3.21	3.13	2.68	**2.87**	S3 new
SSD1478-160	1206-1/1/2/3*WID902	2.59	3.20	2.95	2.86	**2.90**	S3 new
SSD1479-003	1206-2/5/6/3*WID902	2.57	3.04	3.00	3.00	**2.90**	S3 new
SSD1479-015	1206-2/5/6/3*WID902	2.57	3.04	2.25	2.79	**2.66**	S3 new
SSD1479-018	1206-2/5/6/3*WID902	3.57	3.22	3.39	3.05	**3.31**	
SSD1479-035	1206-2/5/6/3*WID902	2.78	3.67	3.13	2.91	**3.12**	S3
SSD1479-083	1206-2/5/6/3*WID902	3.72	3.04	3.00	3.14	**3.23**	
SSD1479-106	1206-2/5/6/3*WID902	4.14	3.25	2.79	3.00	**3.30**	S3
SSD1479-111	1206-2/5/6/3*WID902	3.24	3.33	3.18	2.91	**3.17**	
SSD1479-117	1206-2/5/6/3*WID902	2.82	2.78	3.23	3.00	**2.96**	S3
SSD1479-156	1206-2/5/6/3*WID902	3.11	3.22	3.17	3.19	**3.17**	S3 new
SSD1479-164	1206-2/5/6/3*WID902	3.17	3.32	3.56	2.21	**3.06**	S3
1333-31-2	2-49B1-6*1158A3-1	2.27	4.09	3.35	3.85	**3.39**	
1333-33-3-3	2-49B1-6*1158A3-1	2.00	2.18	2.61	2.55	**2.33**	
1333-33-4-2	2-49B1-6*1158A3-1	2.10	2.78	3.10	2.53	**2.63**	
1333-33-4-4	2-49B1-6*1158A3-1	2.40	2.90	2.23	2.05	**2.39**	
1333-54-b4	2-49B1-6*1158A3-1	2.08	2.45	2.64	1.93	**2.28**	
1333-72-3	2-49B1-6*1158A3-1	1.47	2.32	2.44	1.85	**2.02**	
1333-73T-2	2-49B1-6*1158A3-1	1.79	2.41	2.78	2.22	**2.30**	
1333-92-2	2-49B1-6*1158A3-1	1.79	2.00	1.81	2.30	**1.97**	
1333-116-B	2-49B1-6*1158A3-1	1.73	2.59	1.41	1.76	**1.87**	
1333-188-8	2-49B1-6*1158A3-1	1.90	2.36	1.43	1.90	**1.90**	

In Figure 2 are shown the results of a yield trial sown at Roseworthy by the University of Adelaide Durum breeding program. The SAGIT lines are shown in green and variety checks in pink. The line SSD1476-067 has been put into UA S4 trials in 2018. The best 9 remaining lines have returned to S3 trials in 2018. Line 1349-52-5-1 has resistance derived from the variety Kukri and WID902. The others have resistance derived from *Triticum dicoccon* and WID902.

Figure 1.



In Figures 2 and 3 are shown lines that were included in the UA breeding program S1 trials at Kaniva and Roseworthy in 2017. Varieties are red and SAGIT lines in blue/green. Two lines of particular interest are shown in green. SSD1479-015 appears to have particularly good crown rot resistance and yield. Whilst 1349-52-5-2 is another Kukri derivative that may have better quality.

Figure 2. Yield in UA breeding trial at Kaniva in 2017.

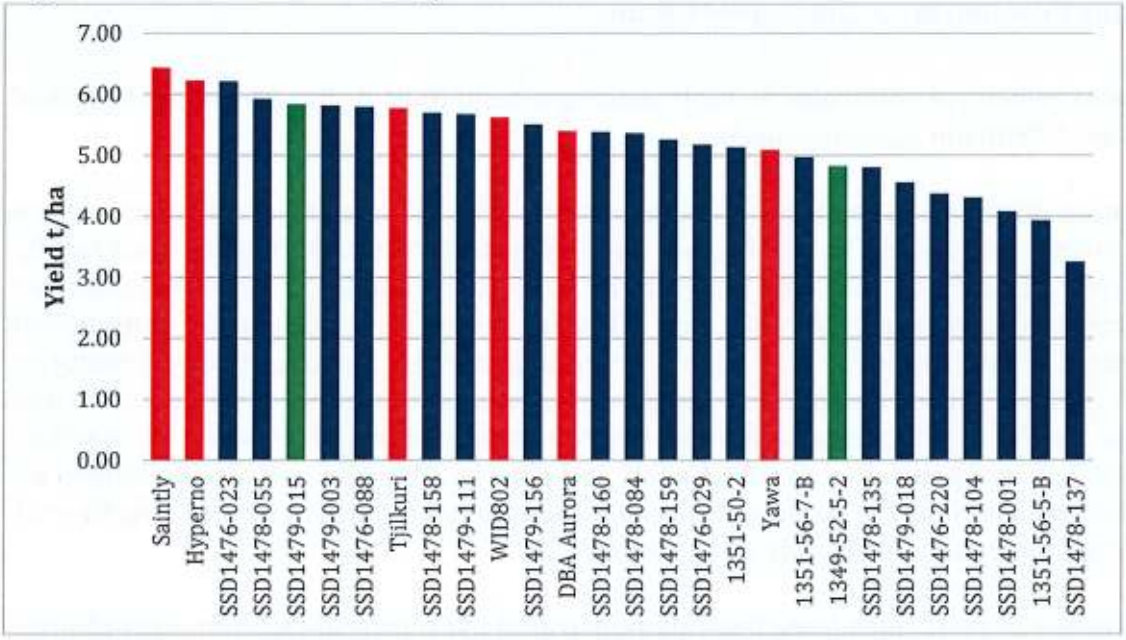
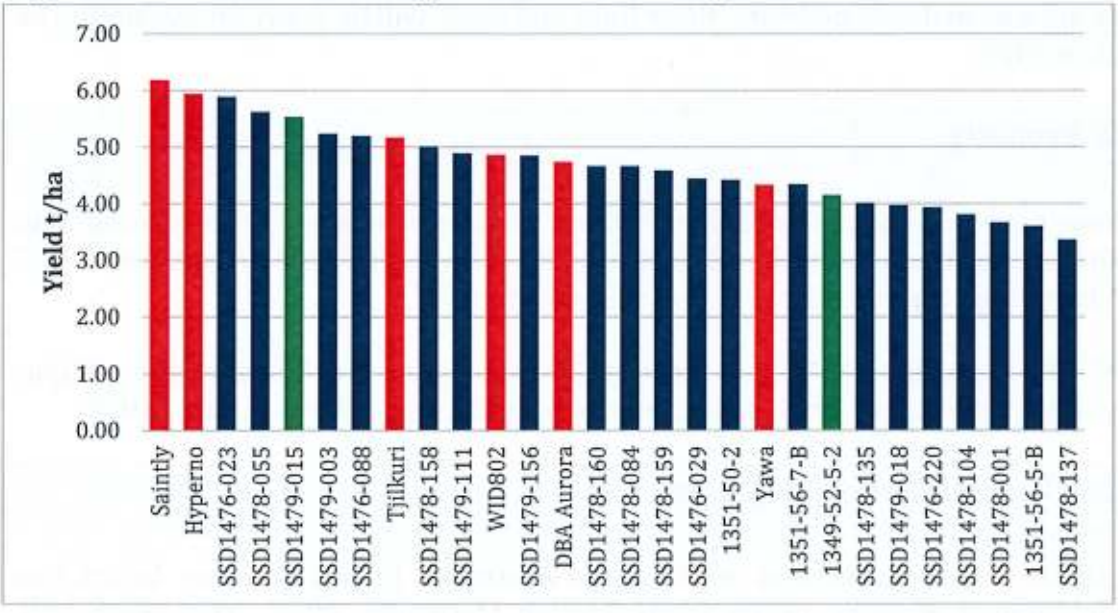


Figure 3. Yield in UA breeding trial at Roseworthy in 2017.



These data show that the SAGIT lines shown here have useful resistance to crown rot consistent with an MS rating and have yields that are comparable to some of the commercial varieties currently grown.

In addition to these data molecular markers have been used by the University of Adelaide marker lab on the S3 trial lines to test for the presence of favorable alleles of the lipoxygenase and Psy-A1genes that affect flour colour. All these lines have the best alleles for the two genes indicating good yellow flour colour. The lines also all have a favorable boron tolerance gene.

Conclusions Reached &/or Discoveries Made

Resistance to crown rot confirmed in high yielding durum lines derived from bread wheat Kukri and wild *Triticum dicoccon* species.

A collection of lines developed from bread wheat and wild *Triticum dicoccon* species were tested for crown rot resistance over 4 years on the Waite terraces and in yield trials run by the University of Adelaide breeding program in 2015, 2016 and 2017. Several lines have shown consistent levels of resistance and yields at levels high enough for commercial consideration, albeit slightly lower than the leading variety Aurora. Quality testing in Tamworth indicates that most of these lines have good quality profiles although most had rather poor results on the mixograph indicating a tendency to dough breakdown. One line, SSD1476-067, is being included in UA S4 trials at 7 sites in 2018 and will also be bulked up for potential inclusion in NVT trials and possible commercial release in future. A further 17 lines have been included in S3 trials at 4 sites in 2018.

Very high levels of resistance have been demonstrated over several years in a set of lines derived from the bread wheat line 2-49 and *Triticum dicoccon*. These lines however are tall, prone to lodging and only have yield around 40-50% of Aurora. New crosses and populations have been developed from these lines and these will be ready for evaluation on the terraces in 2019.

Intellectual Property

All of the lines developed have IP attached to them and one or more of the advanced lines have the potential to be commercialised. Seed of some of the lines has been provided to AGT and the UA breeding program for use in crossing under an MTA.

One line 1476-067 may enter NVT trials on 2019. If that happens and if San Remo are happy with the quality then a commercial partner will be sought for possible release in 2020.

Application / Communication of Results

Dr Wallwork presented his work at the Southern Australian Durum Growers Association (SADGA) Field day at Wolseley in the South-East on 11 October 2017. This was a well-attended event with around 30 people present. Marg Evans made a similar presentation at the SADGA field day at Kingsford on 6 September with 25 people present.

Presentations were also made at SADGA Research Forums at Tarlee on 7 March (Marg Evans) and Horsham on 21 March (Hugh).

The main points communicated were:

- Durum lines with resistance to crown rot equivalent to an MS rating and yield comparable to commercial cultivars have been developed and are in yield trials around SA in 2018.
- One line, 1476-67, is in S4 trials at 8 sites and will be considered for NVT trials in 2019 and subsequent commercial release subject to quality testing after harvest.
- Lines with higher levels of resistance and others with improved quality are under development.

If a resistant variety is developed then the area sown to durum should be able to expand significantly taking in areas where the risk of crown rot had previously been shown to be too high. In other regions where durum is currently grown then durum should be able to be grown more frequently in the rotation instead of only every 4 years.

POSSIBLE FUTURE WORK

We were hoping to be included in a new GRDC crown rot in durum project to run for the next 5 years. This has not eventuated and SAGIT have continued to fund a new project S118 for another year. We do not anticipate GRDC funding this project in the foreseeable future so we will be seeking ongoing SAGIT funding from 2019.

For 2018 we are testing a further 330 lines derived from crosses between a Kukri derived durum and an elite durum breeding line from the UA breeding program. This should provide resistance in a higher yielding background and improved dough stability. These lines are also being subject to molecular marker analysis to identify the locations of genes contributing to the crown rot resistance.

Crosses made in the past year are being progressed in the glasshouse to develop new lines for screening in 2019 and beyond.

New crosses have also been made based on the 2017 resistance scores, yield and quality data for screening in 2020 and beyond.

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