FINAL REPORT 2010

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Project No:	**Project Title:** 2009/10 Research and Extension Project on Durum Agronomy in SA.	
Previous Project(s)		
Organisation: Durum Growers Association of SA Inc**.**		
ACN/ABN: 65-351-773-505		
Start Date: 1/07/2009		
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1. EXECUTIVE SUMMARY

The South Australian durum industry is poised to benefit from new durum variety releases. The purpose of this research was to validate or renew existing agronomic practices in respect of seeding dates, seeding rates and optimum nutrient requirement and management amongst the new durum varieties. The key outcomes from 2009 below highlight that marketable improvements have been made amongst new durum varieties in terms of grain yield and quality. This research will ultimately enable durum growers to increase productivity and reduce risk associated with growing durum in Southern Australia

Key Research Findings:

- When sown early, the newer varieties (WID803, Hyperno, WID802, and Saintly) have a much higher yield potential than the older varieties Tamaroi and Kalka, and the recent release, Caparoi. There are few varietal differences in grain yield when sown late, but more in grain quality; with Caparoi maintaining the best quality when sown late.
- Changes in seeding rate had no effect on grain quality or crown rot infection in 2009 but grain yield increased slightly with seeding rate at Turretfield, and all varieties responded similarly.
- At Hart in 2009, there was no grain yield response to N application but application of N at flag leaf emergence (GS37) significantly increased grain protein.
- Newer varieties may potentially require more N to achieve protein greater than 12.5%. However, the seemly greater nitrogen requirement by some new varieties is going to require careful management; too much early N could predispose the crop to a higher risk of grain quality reductions.
- Withholding N was the most economically viable treatment in a heat stress affected trial at Bordertown in 2009. The new higher yielding durum varieties (WID802, WID803, WID801, Hyperno) benefited most from the withholding of nitrogen because of their greater tendency for quality reductions. Saintly's (early maturing) grain quality was least affected by late heat stress due to its maturity differences and Caparoi maintained its superior grain quality reputation.

BUDGET SUMMARY

BUDGET			
Category	**$**	**$**	**$**
	2009/2010	**2010/2011**	**2011/2012**
Salaries			
Travel			
Operating	$16,000		
Capital			
TOTAL SAGIT CONTRIBUTION	$16,000		
Durum Growers Ass in kind contribution SARDI in kind contribution Landmark in kind contribution	$3,000 $10,000 $7,000		
Host organisation in-kind contribution*			
Total Host Contribution	$20,000		
Other funding bodies contribution eg. GRDC **			
Other third parties contribution **			
TOTAL NON-SAGIT CONTRIBUTION	$20,000		
TOTAL VALUE OF APPLICATION	$36,000		

* If it is not possible to specify amounts, then a description of the nature of the contribution should be given.

** Indicate amount and whether funding has been granted or is awaiting decision.

EXPLANATORY NOTES ON BUDGET ITEMS:

Operating Costs cover consumables and vehicle costs involved in conducting field experiments at Hart, Frances and Turretfield

Non-SAGIT contributions comprise:

Durum Growers Association – salary and on costs for DGA committee members (Chairman, Secretary) in project management,

Landmark - salary and oncost for Leighton Wilsch (Landmark R&D manager) and operational costs for implementation of the Paskeville site

SARDI - salary and oncost for Rob Wheeler (P04, Leader, New Variety Agronomy Group) in project management

3. PROJECT AIMS

To study, develop and communicate improved management practices involving seeding rates, nutrition and Durum varieties across the growing regions of SA.

4. PROJECT ACHIEVEMENTS

4.1 Research results and benefits (in KPI terms)

Key Performance Indicators

No.	KPI	Date completed
1	**Plan and conduct Trials** All of the following trials were successfully sown and	**31/12/2009**

	harvested during 2009. Trials from the South East had a greater degree of variability due to untimely heat stress during grain fill. *1. Hart [Mid North]* The interaction between durum varieties and seeding rate on Grain yield and quality. *2. Rosedale [Lower North] Turretfield Research Centre* The interaction between durum varieties, time of seeding and Seeding rate on grain yield and quality. *3. Paskeville [Yorke Peninsula] & Bordertown [South east]* The interaction between durum varieties and trace elements and nitrogen management on grain yield and quality. *4.Frances[South East]* The interaction between durum varieties and seeding rate on Grain Yield and Quality.	
2	**Results published in Farm Magazines** *Key Results:* **Seeding Rate - *Hart/Frances:*** • Durum varieties responded similarly to changes in seeding rate and there was found to be no effect of seeding rate on grain yield, quality or crown rot infection. **Time of Sowing - *Turretfield*** Results are tabulated in appendix 1 • Increasing seeding rate proportionally increased yield slightly • When sown early the newer varieties (WID803, Hyperno, WID802, and Saintly) have a much higher yield potential than the older varieties Tamaroi and Kalka, and new release Caparoi • Minimal varietal yield differences when sown late but grain quality is more important; • Caparoi maintained the best quality at late sowing **Nitrogen Trials:** ***Paskeville*** • Entire N applied at GS31 or split between GS31 & 47 resulted in the highest yield but varieties do not respond differently, no quality differences. ***Hart*** • Application of N at flag leaf emergence (GS37) significantly increasing protein, no varietal differences ***Bordertown***	**31/5/2010**

	• Withholding of nitrogen application proved to be the most economically viable in stressful conditions. • Late stress exposed some of the newer durum varieties (WID803, WID803) to have grain size reductions. During 2009/10 field days and crop walks were undertaken in collaboration with existing farmer driven research sites the McKillop Farm Management Group, Hart Group and AWB Landmark. Farmers were addressed by Rob Wheeler, John Green, Dr Tony Rathjen, and Leighton Wilksch. The key results and benefits are outlined in this report below and the key outcomes of all the 2009 agronomy trials were compiled and presented at the Durum Growers of SA Inc Annual pre-seeding forum, along with an extensive final report which is available online at the DGA website :(URL:www.durumgrowerssa.org.au). Results from the HART site in 2009 were published in the HART trial results books and all of the key findings from the 2009 trials have also been outlined in the HART Group Official Field Day Guide for 2010.	

4.2 Intellectual Property

All findings will be made freely available to grain producers and agribusiness community.

4.3 Suggested future research

There is considerable potential for further research to better understand how to manage and reduce the risk associated with growing durum. Durum agronomy trial results from 2009 have identified the marketable improvements in grain yield achieved with the growing the newer durum varieties. Important data has come out of the project to date but there is still a substantial need to further develop an understanding of varietal responses across seasons and sites. Hence, more research across seasons and sites looking at the same fundamental agronomic practices such as seeding rate, sowing time, and nutrient management will be need to be continued.

Many durum growers are beginning to question the validity of current practices of high seeding rates and early N application, which may potentially exacerbate crown rot and reductions in grain size. Although more data is needed; results from 2009 have indicated that reducing seeding rates is not likely to incur a yield loss or improve grain quality. However the current practice of higher seeding rates is often used to improve crop competition with grass weeds. If growers are considering reducing seeding rates, research should be conducted to determine the likely impacts of lower plant densities in terms of crop competition in the new varieties. The new varieties exhibit different growth structural characteristics compared to old varieties such as more erect growth habit and less leaf area; all of which are traits that influence competitive ability; therefore varietal specific weed competition research may be beneficial.

Using N to manage grain quality, and in particular protein, is going to be a key issue in managing the new high yielding varieties, as initial results suggest that in good spring conditions they may require more N to achieve the required protein. However the seemly greater nitrogen requirement by some new varieties is going to require careful management, as too much early N could predispose the crop to a higher risk of grain quality reductions. More data is needed to determine the N requirements of the new varieties.

Durum appears more susceptible to stress (heat, cold, and nutrient deficiencies) than bread wheat, however the newer varieties may be better adapted to more hostile environments and research should continue in developing agronomic practices to better manage durum in stressful environments. As highlighted by the damaging heat stress in the South East in 2009, more research is needed to understand the mechanisms and processes involved in improving heat stress tolerance in durum. Research should ultimately be focussed on management strategies that are likely to assist growers in reducing the risk in growing durum to improve production and adoption.

5. APPLICATION OF RESULTS TO THE INDUSTRY

5.1 Potential Industry impact

SA Durum grain production has fallen steadily in recent years from 95,000 ha producing 324,000 tonnes in 2001/02 to 59,100 ha producing 88,650 tonnes in 2008/09 (PIRSA Rural Solutions Estimates SA). Feedback from growers suggests the high risk associated with growing durum is a key factor involved in the decline of durum grain production in SA. However, SA durum growers have welcomed the release of new durum varieties and those coming on stream which offer improvements in grain yield, semolina colour, and have exhibited slightly less Fusarium (Crown Rot) susceptibly. The new releases herald a turning point for durum production in SA and are cause for greater excitement highlighting the potential for greater adoption of durum across the state. The new durum varieties exhibit differences in growth and structural characteristics that are potentially more similar to that of bread wheats and also vary in flowering time and ancestry. As a result this agronomic research is very important in validating or renewing existing agronomic practices in respect of seeding dates, seeding rates and optimum nutrient requirement and management. In conjunction with NVT data the purpose of the current research is to help develop agronomic packages better suited to the new durum varieties. With more research across seasons and regions, the key outcomes from this research will ultimately enable durum growers to increase productivity and reduce risk associated with growing durum in Southern Australia.

The key outcomes from the 2009 research have been summarised below and highlight that marketable improvements have been made amongst the new durum varieties in both grain yield potential and grain quality.

Time of Sowing:

In response to different management practices these initial results do support the general consensus that some of the newer durum's have improved yield potential and behave in slightly different ways to the 'traditional' durum varieties such as Tamaroi and Kalka. When sown early the newer varieties (WID803, Hyperno, WID802, and Saintly) have a much higher yield potential than the older varieties. Although Caparoi is a later maturing variety it showed it cannot match the yield of the other new releases even when sown early. When sown later (mid) WID803 proved it can still yield higher than Caparoi, Kalka, and Tamaroi and the same as all other varieties when they were sown early. Hyperno appeared quite sensitive to sowing time suggesting it will likely benefit the most from early sowing (figure 1).

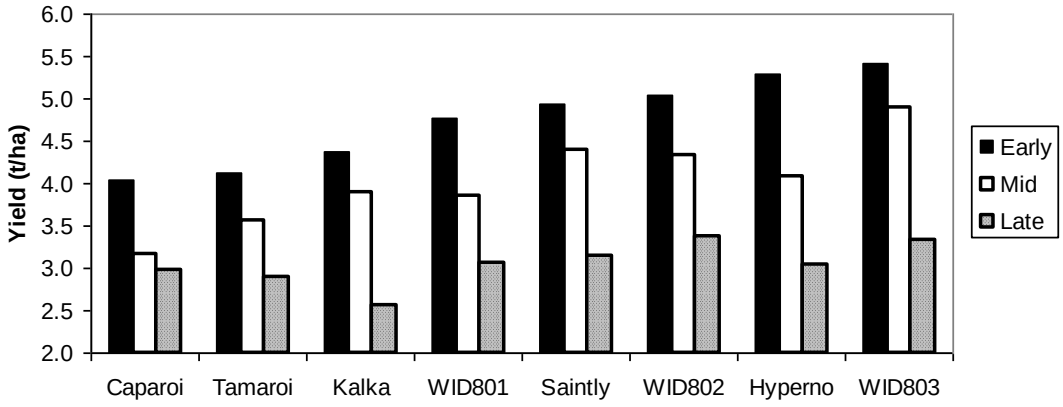

Figure 1. Varietal grain yield data averaged across all seeding rates at different times of sowing (Early -11 May, Mid 1- Jun, and Late -24 Jun) at Turretfield 2009.

The biggest factor influencing the financial return ($/ha) at early and mid sowing was yield (appendix 1). Quality did not play a key role and only differences in grain protein affected the grade received. Nitrogen was not applied to this trial, as the site was considered non responsive, but the higher grain protein in some lower yielding varieties such as Caparoi and Kalka would indicate a possible soil nitrogen limitation (ie N yield dilution effect). When sown early more nitrogen may be required by newer higher yielding varieties in order to achieve the required protein. WID803's pure ability to yield gave it the top gross return overall at early sowing and was still third overall at mid sowing.

Choosing a variety with reliable grain quality is more important when sowing late as varieties may be in grain fill during hot dry spring conditions as was the case in this trial. The trial has indicated yield differences amongst varieties are minimal at late sowing but quality differences become very important. With the exception of Caparoi these results confirm previous results showing many newer varieties/breeders lines to be more susceptible to quality downgrades due to reduction in grain size when exposed to stress during grain-fill. At late sowing Caparoi's yield was the same as all other new releases but its quality was superior, and it was the only variety to achieve the top bin grade (DR1). Caparoi came out on top in terms of gross return at late TOS.

Seeding Rate:

Many durum growers are beginning to question the validity of current practices of high seeding rates which may potentially exacerbate crown rot and cause reductions in grain size. Across all seeding rate trials conducted in 2009, the results suggest durum varieties do not respond differently to seeding rate, and reducing seeding rate does not change grain quality. Grain yield was only affected by changed seeding rate at Turretfield, where in this higher yielding environment increasing seeding rate proportionally increased yield slightly (table 1). Based on 2009 results there appears to be no effect of seeding rate on grain quality or crown rot, however more data from across seasons is needed to see if different spring conditions will identify any key differences.

Table 1. Grain yield and quality data results averaged across all varieties in response to SR, Turretfield 2009

Seeding Rate (seeds/m2)	Grain yield (t/ha)		Grain Weight (mg)	Screenings % (<2mm)	Test weight (kg/hl)	Protein % (db)
160	3.85	a	40.8	1.4	75.1	12.5
190	3.91	b	40.8	1.4	75.1	12.5
220	3.98	c	40.8	1.4	75.1	12.5
250	4.03	d	41.1	1.2	75.6	12.3
LSD (0.05)	0.019		ns.	ns.	ns.	ns.

Nitrogen regimes:

Growers are also questioning the validity of applying large amounts of nitrogen early in the growth of durum, as this has the potential to increase the onset of moisture stress in spring and hence greater chance for crown rot infection, and reductions in grain quality. It is also of interest to question whether newer varieties, with less leaf area relative to old varieties like Tamaroi and Kalka, are less responsive to nitrogen and require less application or alternatively, being higher yielding, require more N to achieve the required protein. At Paskeville in 2009, the research found that all N applied at GS31, or split between GS31 & 47, produced the highest yield but varieties did not respond differently. N application did not change any key grain quality parameters; however the highest yielding varieties (WID803 and Hyperno) produced the lowest protein, suggesting they may in fact require more N than other varieties.

Additionally, in the drier environment at Hart, there were no significant varietal interactions and nitrogen application did not change grain yield, but did influence grain quality. The application of N at flag leaf emergence (GS37) significantly increasing protein. It is important to note that these two trials had ideal growing conditions in late spring. The moisture stress experienced in previous springs, that led to reduced quality in bulky N rich crops, were not evident; possibly masking grower concerns about the negative implications of early N application. Protein management is going to be a key issue in the new high yielding varieties and growers may actually need to apply N later in the season to achieve the required grade.

The other nitrogen trial at Bordertown experienced completely different spring conditions, early growing conditions were favourable and a high yield potential was established. However an untimely severe heatwave occurred during grain fill, effectively shutting off the season. Conditions were detrimental to varieties with high bulk and leaf area and those which had not already filled grain; as a result there are significant grain yield and quality varietal interactions. The withholding of nitrogen application proved to be the most financially viable treatment, as there was reduced green leaf area. Whilst all quality was poor, the late stress did reveal some of the newer durum varieties (WID803, WID801) as having higher screening levels, and lower test weights (table 2). Differences in maturity were highlighted with the earlier maturing variety Saintly performing best in terms of grain quality due to the season shutting off.

Table 2. Varietal grain quality averaged across all N treatments in heat stress affected trial at Bordertown SA, 2009

Variety	Screenings % (<2mm)	Test weight (kg/hl)
Tamaroi	7.2	68.5
Saintly	7.3	70.0
Caparoi	11.3	68.7
Kalka	13.1	66.7
Hyperno	14.1	67.1
H802	15.5	63.6
H801	23.4	62.9
H803	25.2	64.1
Site mean	14.6	66.5
LSD (<0.05)	3.3	1.0

In terms of grain yield, interestingly the higher yielding Adelaide Uni lines benefited most from no N at all (figure 2). Spring events such as this; highlight the difficult in making N decisions for durum in areas with unpredictable spring conditions. This information is very important for the durum growing industry as it will assist grower decisions going forward in these high stress environments.

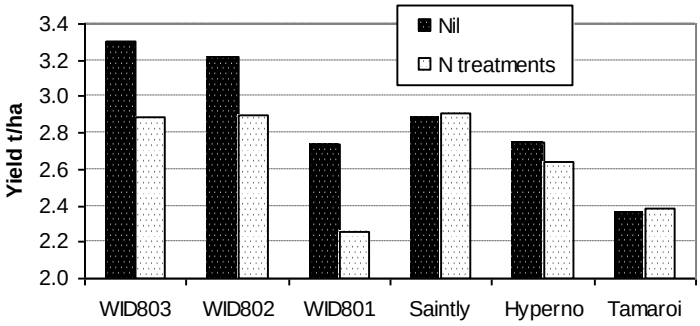

Figure 2. Grain yield (t/ha) of nil nitrogen and average yield of all other N treatments (no sig differences between all three).

Conclusion:

Across a series of unfavourable seasons, older durum varieties have developed the reputation of having greater yield and quality reductions than bread wheat in dry springs, resulting in lower gross margins with increased risk. This experience with durum, has hampered grower confidence in continuing to grow durum, and consequently durum production and adoption has been slowly declining. The release of new variety which are more widely adapted, have higher yield potential, and improved grain quality, coupled with extensive agronomic information, will assist in increasing durum production in SA. While more data from across seasons and sites is needed, these results begin to develop a body of information that will ultimately contribute to developing better variety specific agronomy packages for durum varieties. In particular, and highlighted by the time of sowing and other trials, the new varieties provide growers with potential increases in economic return and strategies to reduce risk. The continuation of this research, and communication of results to growers, will help address grower concerns that are currently inhibiting durum production and adoption based around minimising the risk associated with growing durum and maximising grain quality. Growers outside of the traditional durum-growing areas of the Mid North and Yorke Peninsula may soon have the opportunity to grow durum upon further results from this research.

5.2 Suggested path to market for the outcomes

The path to market for the outcomes of this project are through:

- the ongoing communication of the management practices that best fit the new durum varieties will continue to be demonstrated at field days, seminars, grower meetings and referenced in publications in conjunction with the 2010 durum agronomy research program (GRDC). Durum research is continuing in 2010 and is aiming to research the same agronomical practices studied in 2009, to develop a stronger dataset of results. This Durum Growers Association driven project will continue to highlight and reference all of the outcomes from this research in subsequent publications and related research programs to inform the durum industry about the possibilities for improved production with new durum varieties and better agronomy.
- Outcomes will be further promoted at the annual Durum Growers Association of SA forum.
- The final report from the 2009 work will continue to be widely promoted at crop walks and field days amongst the durum industry and is available online at the new DGA website: (URL:www.durumgrowerssa.org.au) where results can be accessed by any members of the public.

5.3 Communication of outcomes to date to growers, advisers, processors, marketers, and other scientists

During 2009/10 field days and crop walks across the agronomy trials were undertaken in collaboration with existing farmer driven research sites, the McKillop Farm

Management Group, Hart Group and AWB Landmark. Farmers were addressed by Rob Wheeler, John Green, Dr Tony Rathjen, and Leighton Wilksch.

Key outcomes of all the 2009 agronomy trials were compiled and presented by Kenton Porker, Rob Wheeler, and John Green at the Durum Growers of SA Inc Annual pre-seeding forum which consisted of members from all facets of durum production including growers, advisers, processors, marketers, other scientists, and the rural press.

An extensive final report from the 2009 trials is being widely promoted at crop walks and field days amongst the durum industry and is available online at the new DGA website: (URL:www.durumgrowerssa.org.au).

Results from 2009 were published in the official 2009 HART results books and also the outcomes of the Durum research were presented to the Adelaide Uni Advance Agronomy students to assist in management decisions for a durum crop competition at Roseworthy.

Key findings from 2009 have been outlined in the HART Group Official Field Day Guide for 2010 with plans to continue to present the information at relevant crop walks, field days, and advisory updates throughout 2010.

6. SUGGESTION FOR FURTHER WORK ARISING FROM THE PROJECT

Further work arising from this project has been discussed in detail in section 4.3. Further work should focus on continuing the current research in order to develop more conclusive outcomes in terms of management strategies for new durum varieties. Other research should focus on further understanding heat stress and improving heat stress tolerance in durum as well as focussing on grain quality constraints such as protein and grain size in the new varieties. Little is also known about the relative competitive abilities of the new varieties.

It is important to continue research in the traditional durum-growing areas of the Mid North and Yorke Peninsula to further validate and renew existing agronomic practices; however upon release of new varieties there is a great opportunity to expand research into other areas where durum is not commonly grown such as the South East and in other agricultural areas. To date there is little or no published literature on any of the new durum varieties, more information about how better to grow these varieties is needed if there is going to be an increase in durum production in SA.

7. PERSONNEL, including any changes during the project

The project is primarily led and managed by the SA Durum Growers Association, headed by Mr John Green, (Chairman Durum Growers Ass of SA)

The field work component of the project, data collection and analysis was conducted by SARDI from July 2009 led by Mr Rob Wheeler, Principal Research Scientist, SARDI, Waite with assistance from Mr Kenton Porker Research Officer, SARDI Waite.

The Paskeville nitrogen trial was conducted and managed by Mr Leighton Wilsch (Landmark R&D manager)

8. PUBLICATIONS

Porker K.,& Wheeler R., 2010. *2009 Durum Agronomy Trial Results.* Durum Variety and Agronomy Research; Durum growers association of SA. Online., URL:[http://www.durumgrowerssa.org.au/industrynews.htm]

Hart group et al, 2009. *Durum Management*. Hart field trial results 2009. pp 38 - 42

9. AUTHORISATION OF THE REPORT

Signature: **Date:**

Appendix 1: Durum variety grain yield and quality results across different times of sowing at Turretfield, 2009, including economic return ($/ha)

TOS	Variety	Yield (t/ha)	Grain Weight	Screenings (<2mm)	Test Weight (kg/hl)	Protein (db)	Bin grade*	Return $/ha	Rank	$diff to top
Early	Caparoi	4.04	49.7	0.2	78.7	12.0	DR2	804	12	-209
	WID801	4.77	42.9	0.5	74.9	10.0	DR3	892	6	-121
	WID802	5.04	41.5	0.7	74.1	10.9	DR3	943	4	-70
	WID803	5.42	40.0	0.7	76.6	10.0	DR3	1013	1	0
	Hyperno	5.28	44.6	0.4	75.2	10.0	DR3	988	2	-25
	Kalka	4.38	45.5	0.2	78.2	11.3	DR3	819	10	-194
	Saintly	4.93	44.7	0.4	77.0	11.2	DR3	922	5	-91
	Tamaroi	4.12	51.2	0.3	77.1	10.7	DR3	770	13	-243
Mid	Caparoi	3.17	45.5	0.2	78.2	13.2	DR1	707	16	-306
	WID801	3.85	44.0	0.5	76.1	12.6	DR2	765	14	-248
	WID802	4.33	42.8	0.4	76.0	11.5	DR2	861	9	-152
	WID803	4.89	38.1	0.8	76.8	11.5	DR2	972	3	-41
	Hyperno	4.08	41.3	0.4	76.1	12.5	DR2	812	11	-201
	Kalka	3.89	43.4	0.2	78.5	13.4	DR1	868	8	-145
	Saintly	4.41	42.3	0.3	76.9	12.4	DR2	877	7	-136
	Tamaroi	3.57	48.9	0.2	77.6	12.7	DR2	711	15	-302
Late	Caparoi	2.99	38.2	1.3	75.3	15.5	DR1	666	17	-347
	WID801	3.06	32.6	3.0	69.8	13.5	DR3	572	21	-441
	WID802	3.37	34.3	3.2	71.2	13.5	DR3	630	18	-383
	WID803	3.34	30.9	5.6	72.5	13.1	DR3	625	19	-388
	Hyperno	3.04	32.9	6.0	71.8	14.2	DR3	568	22	-445
	Kalka	2.56	35.9	1.4	73.3	15.2	DR3	479	24	-534
	Saintly	3.14	35.2	2.3	72.5	14.2	DR3	587	20	-426
	Tamaroi	2.90	39.6	1.8	72.8	14.7	DR3	542	23	-471
LSD (0.05)										
TOS		0.28	0.43	0.13	0.40	0.16				
Variety		0.45	0.70	0.22	0.65	0.27				
TOS*Variety		0.55	1.22	0.37	1.12	0.46				

	DR1	DR2	DR3
Protein min (%)	13	11.5	10
Test Weight Min (kg/hl)	74	74	71
Screenings <2mm (%by weight)	5	5	10

*Bin price: based on Vittera, DR1 = $223/t DR2 = $199/t DR3 = $187/t