2009

Durum Variety and Agronomy Research

By the

Durum Growers Association of SA

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2009 Durum Agronomy Trial Results

compiled by Kenton Porker & Rob Wheeler, SARDI

Introduction:

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. It is accepted that some of the newer durums have improved yield potential, however may behave in different ways to the 'traditional' durum varieties such as Tamaroi and Kalka, with differences in growth and structure characteristics that are potentially more similar to that of bread wheats.

Whilst new durum varieties have been yield and quality tested in NVT trials over recent years, little is known about the way in which varietal differences in adaptation, growth habit and maturity can affect yield and quality parameters in response to changing agronomic practices such as sowing date, seeding rate, and different nitrogen regimes.

In conjunction with NVT data the purpose of the current research is to help develop agronomic packages better suited to the new durum varieties. This will ultimately enable durum growers to increase productivity and reduce risk associated with growing durum in Southern Australia. In 2009 a number of trials were conducted and the results are outlined in this report.

Durum Varietal Response to Nitrogen (N) Timing

Trial objectives:

- To evaluate the effect of nitrogen timing on grain yield and quality of durum wheat varieties in South Australia

How was it done?

Two nitrogen timing trials were conducted at Paskeville and Bordertown; seven varieties of durum were sown along with four nitrogen (N) treatments applied at different times of the growing season in a split plot design with three replicates:

Varieties:	Caparoi, WID801, WID802, WID803, Hyperno, Kalka, Saintly, Tamaroi	
Nitrogen timing:	1. No added N	2. 80kg N at GS47
	3. 80kgN at GS31	4. 80kg N split between GS 31 & GS 47 (40kg each time).

A third nitrogen timing trial was conducted at Hart with six different nitrogen treatments in a randomised complete block design. Urea @ 100kg/ha was incorporated by sowing or broadcast by hand post emergent according to treatment

Nitrogen timing:	Nil	50 % GS 30 + 50% GS 32
	50% IBS* + 50%GS30	100% GS37
	100 % GS 30	50% GS 37 + 50% GS47

IBS* = Incorporated by Sowing

Table 1 Zadoks growth stage and corresponding physiological description of main stem.

Zadoks growth stage value	Physiological description of main stem
GS30	Start of stem elongation
GS31	1st Node detectable
GS32	2nd Node detectable
GS37	Flag leaf emergence
GS47	Flag leaf sheath opening

Normalised Difference Vegetation Index (NDVI) measurements, correlated to biomass, were taken on the 12th August 2009 from the Paskeville trial with a GreenSeeker.

At Bordertown, an additional opportunistic 20kgN top dressing application was applied to half of every plot in response to good seasonal conditions. This reduced plot lengths to 5m within a split split plot design.

Grain yield was measured from every plot and the three replicates composited together to measure grain quality attributes; protein, screenings, 1000 grain weight, and test weight.

2009 Paskeville N Timing Trial

Key Outcomes:

- Varieties responded similarly to nitrogen application
- Applying all N at GS31 and a 50% split between GS31&GS47 produced the greatest yield within all varieties
- Differences in nitrogen application did not change key grain quality parameters.

Yield Results:

- There were no significant interactions between varieties and their response to nitrogen treatments on both grain yield and NDVI (biomass) measurements meaning all varieties responded alike (Table 3).
- There were differences amongst varieties in yield (Table 2) and a general response to nitrogen across the site.
- Both treatments of 80kgN@GS31 and the split application between GS 31/41 increased grain yields by 7% and 80kgN@GS47 resulted in a 3% yield increase over no applied N (3.91t/ha).
- WID803 and Hyperno were the top yielding, and Tamaroi the lowest yielding variety at 7% below site average.
- NDVI (GreenSeeker) managed to detect biomass differences in both varietal and N treatments; however it did not correlate to grain yield.

Table 2. Grain yield and quality data averaged across nitrogen treatments, Paskeville 2009

Variety	Yield (t/ha)	NDVI	Protein % (db)	Screenings % (<2mm)	Test weight (kg/hl)
WID803	4.47	0.67	11.1	3.6	82.2
Hyperno	4.24	0.72	11.1	1.9	82.2
WID802	4.19	0.70	11.7	3.5	81.0
WID801	4.10	0.61	12.0	3.5	82.0
Caparoi	4.03	0.72	12.3	2.2	84.0
Kalka	3.97	0.75	12.2	3.1	83.9
Saintly	3.95	0.69	12.4	2.9	83.4
Tamaroi	3.81	0.75	11.4	2.9	83.0
Site mean	4.10	0.70	11.7	2.9	82.7
LSD (P<0.05)	0.24	0.08	0.5	1.0	0.5

Table 3 Grain yield (t/ha), and NDVI data averaged across all varieties Paskeville N timing trial 2009

Nitrogen Timing	Yield (t/ha)		NDVI	
80kgN@GS31	4.23	a	0.73	a
split b/w 31/47	4.21	a	0.71	ab
80kgN@GS47	4.03	b	0.67	b
Nil	3.91	c	0.68	b
LSD (P<0.05)	0.10		0.05	

Grain Quality Results:

- The nitrogen timings did not significantly affect any grain quality parameters.
- Varietal grain quality differences were evident in the trial outlined in Table 2. Caparoi produced the best grain quality.
- The main quality constraint was protein, with no variety or treatment achieving greater than 12.5% protein.
- All test weights were high, being above 80kg/hl, and all screenings below five percent.

Discussion

Applying the entire N at GS31 or having a 50% split application between GS31 & 47 were the best options in terms of achieving higher grain yield. However, since N application did not change grain quality or reach the required protein for DR1 this suggests more nitrogen was actually needed. The newer varieties and especially WID803 proved their excellent yielding ability and whilst slightly lower yielding, Caparoi maintained its reputation for improved grain quality.

2009 Hart N timing trial

Key Outcomes:

- Applying all of the nitrogen at flag leaf emergence (GS37) increased protein

Results:

- Durum grain yield was not influenced by nitrogen timing (Table 4).
- Screenings (averaging 0.5%) and test weight (averaging 80kg/hl) were also not influenced by nitrogen timing.
- Protein was higher (13.9%) when all of the nitrogen was applied at GS37 compared to all other treatments which were similar with an average of 13.1%. However this treatment produced the lowest test weight of 79.5kg/hL (Table 4).

Table 4 Grain yield and quality parameters results, nitrogen timing trial at Hart in 2009.

Nitrogen timing	Grain yield (t/ha)	Protein (%)	Test Weight (kg/hl)	Screenings (%)	Grain weight (mg)
Nil	2.84	13.2	80.0	0.5	48.4
50% IBS + 50%GS30	2.83	13.0	79.7	0.6	47.6
100 % GS 30	2.84	13.2	79.7	0.5	47.3
50 % GS 30 + 50% GS 32	2.91	12.8	80.0	0.5	47.5
100% GS37	2.82	13.9	79.5	0.7	46.5
50% GS 37 + 50% GS47	2.88	13.2	80.0	0.5	48.9
LSD (0.05)	ns	0.4	0.4	ns	ns

2009 Bordertown N Timing trial

Key Outcomes:

- Nil N application was the most economically viable treatment due to late season heat stress.
- Newer durum varieties have higher yield potential but a greater tendency for quality reductions.
- Saintly (early maturing variety) was least affected by late season heat stress.

Yield Results:

- The late season topdressing of 20kgN had no effect on grain yield or all quality parameters.
- Varieties responded differently to nitrogen regimes (Figure 1& Figure 2) and the response can be broadly explained by four categories.

1. WID803, WID802, and WID801 all achieved greatest yield with nil N.
2. Hyperno, Saintly and Tamaroi had no difference in yield between all of the other three N treatments compared to the control (nil N).
3. Kalka had its highest yield at nil N application and the split application yielded similar to Hyperno, Saintly, and WID801 (nil).
4. Caparoi had a significantly lower yield from the early application of N @GS31, however with the application of late nitrogen (80kgN @GS 47) yield was significantly increased and managed to yield the same as Saintly, Hyperno, and WID 801 but still did not match top yielding varieties (WID803, 802).

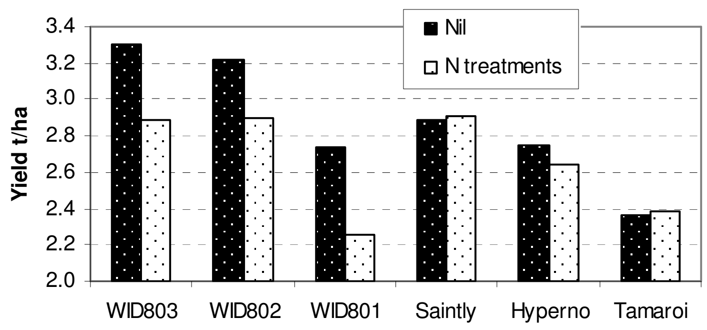

Figure 1. Grain yield (t/ha) of nil nitrogen and average yield of all other N treatments (no sig differences between all three).

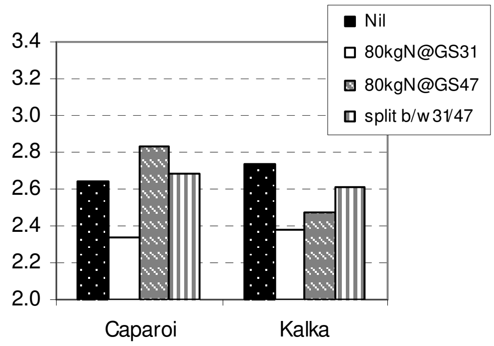

Figure 2. Grain yield (t/ha) of all nitrogen timings on varieties Caparoi and Kalka

Grain Quality

- All varieties responded alike to the different N timings. All varieties (Table 5) and N treatments didn't reach any minimum grain quality receival standards due to high screenings and low test weights.
- Nil nitrogen application produced the lowest protein, significantly lower screenings and higher test weights compared to all other nitrogen applications (Table 6).
- Tamaroi and Saintly produced the lowest amount of screenings, averaging 7% below site average while WID801 and WID803 had high screening levels, approx 10% higher than the site average (Table 5).
- Within the Adelaide Uni lines WID801, WID802, and WID803, test weights were more than 3kg/hl lower than all other varieties. All test weights were less than 70 kg/hl, except within Saintly (Table 5).

Table 5 Grain yield and quality data averaged across nitrogen treatments, Bordertown 2009

Variety	Screenings % (<2mm)	Test weight (kg/hl)	Protein % (db)
Tamaroi	7.2	68.5	18.3
Saintly	7.3	70.0	17.5
Caparoi	11.3	68.7	18.7
Kalka	13.1	66.7	18.1
Hyperno	14.1	67.1	17.5
H802	15.5	63.6	17.4
H801	23.4	62.9	17.8
H803	25.2	64.1	17.7
Site mean	14.6	66.5	17.9
LSD (<0.05)	3.3	1.0	0.4

Table 6 Grain yield (t/ha), averaged across all varieties at Bordertown N timing trial 2009

N treatment	Protein % (db)	Screenings % (<2mm)	Test weight (kg/hl)
Nil	16.0	10.6	68.1
80kgN@GS47	18.5	12.3	66.8
80kgN@GS31	18.5	19.0	65.1
split b/w 31/47	18.6	16.7	65.9
LSD (P<0.05)	0.29	2.34	0.7

Discussion:

Early growing conditions were favourable and a high yield potential was established allowing for the opportunistic topdressing of N in late season. However, a severe heatwave occurred in the first week of November, with temperatures reaching 41ºC during grain fill, after all initial nitrogen applications and topdressing effectively shutting the season off. These conditions were detrimental to varieties with high bulk and leaf area and those which had not already filled grain. Due to this, the withholding of nitrogen application proved to be the most economically viable treatment as there was reduced green leaf area. Spring events such as this, highlight the difficulty in making N decisions for durum in areas with unpredictable spring conditions.

Whilst all quality was poor, the late stress did expose some of the newer durum varieties (WID801, WID803) to have higher screening levels, and also lower test weights under stressed conditions. Differences in maturity were highlighted with the earlier maturing variety Saintly performing best in terms of grain quality due to the season shutting off. Interestingly the higher yielding Adelaide uni lines benefited most from no nitrogen at all. More research is needed to ascertain whether these lines may benefit from cutting back on inputs in stressful environments in order to minimise risk and maximise grain quality.

The untimely heat stress was not ideal for interpreting N response data and drawing any conclusive outcomes, more data from across seasons is needed.

Durum Varietal Response to Seeding Rate

Trial Objectives:

- To evaluate yield and quality performance of new durum varieties at different sowing rates.

Key Outcomes:

- Seeding rate had no significant effect on grain yield or quality at Hart or Frances in 2009
- Increased tillering within Caparoi and Hyperno did not result in increased heads/m^2

2009 Frances Seeding Rate Trial

How was it done?

Eight durum varieties were sown at four seeding rates (SR) in a split plot design with three replicates.

- Seeding Rate (SR): (160, 190, 220, 250 seeds/m^2)
- Varieties: (Caparoi, Hyperno, Kalka, Saintly, Tamaroi, WID801, WID802, WID803,)

Results

- Large variability across site due to heat stress (41ºC, 2nd November) during grain fill caused yield results to be irrelevant for interpretation or use.
- Despite large variability seeding rate had no effect on grain yield. Variety grain yield from the site can be found in Table 7 but should be treated with caution due to large variability.

Table 7. Grain yield results averaged across seeding rate for durum variety at Frances, 2009

Variety	Yield t/ha
WID803	4.83
WID802	4.08
Hyperno	3.50
WID801	3.25
Kalka	2.67
Tamaroi	2.66
Caparoi	2.51
Saintly	2.45
LSD (0.05)	0.57

2009 Hart Seeding Rate Trial

How was it done?

The trial consisted of five varieties and three seeding rates in a randomised complete block designs with 3 replicates.

5 varieties: Saintly, Hyperno, Kalka, Caparoi or WID802

3 seeding rates: Low (150), medium (180) and High (220) seeds sown per square metre

Results:

- Seeding rate produced no significant differences in grain yield or any quality trait measured.
- Hyperno (3.44t/ha) and WID802 (3.50t/ha) were the highest yielding durum varieties. Caparoi, Kalka and Saintly all had similar grain yield averaging (2.94t/ha) (Table 8).
- Protein averaged 12.8% and was statistically similar for all varieties and sowing rates.
- Caparoi produced the highest test weight (81kg/hL), one of the lowest screenings (0.7%) and the highest grain weight (mg).
- Hyperno, Kalka and Saintly had a test weight between 79.6kg/hL and 80.4kg/hL. WID802 had the lowest test weight at 79.0kg/hL and the lowest grain weight (Table 8).

Table 8 Grain yield and quality parameters results averaged across seeding rate for durum variety at Hart in 2009

Variety	Grain yield (t/ha)	Protein (%)	Test weight (kg/hL)	Screenings (%)	Grain Weight (mg)
Caparoi	3.01	13.0	81.0	0.7	53.1
Hyperno	3.44	12.7	79.6	0.6	50.4
Kalka	2.89	12.9	80.4	0.8	49.2
Saintly	2.93	13.0	80.1	1.2	49.0
WID802	3.50	12.4	79.0	1.1	46.8
LSD (0.05)	0.25	Ns	0.4	0.2	1.2

- There were differences in plant density due to seeding rate at emergence (Table 9) but this effect could not be found at tillering, possibly due to plant compensation.
- Not all varieties behaved the same at tillering. Caparoi, Hyperno and Kalka had an average tiller density of 454 tillers/m^2, 20% more that Saintly and breeders line WID802 (Table 10).
- By harvest time there were no significant differences in head number for any variety or seed rate, thus, the extra tillers produced by Caparoi, Hyperno and Kalka were aborted and did not lead to a greater number of heads.

Table 9 Plant density at emergence averaged across the 5 varieties for seeding rate at Hart in 2009

Seed Rate	Plant density (plants/m2)
Low	147
Medium	185
High	222
LSD (0.05)	13

Table 10. Plant density (plants/m^2), tiller density (tillers/m^2) and head density (heads/m^2) averaged across seeding rate for durum varieties at Hart in 2009.

Variety	Plant (plants/m^2)	Tillers (tillers/m^2)	Heads (heads/m^2)
Caparoi	169	449	268
Hyperno	184	444	246
Kalka	197	469	251
Saintly	194	380	264
WID802	179	376	234
LSD (0.05)	17	57	ns

Discussion:

The theory of reducing seeding rates to allow for greater yield and grain quality and has not been proven in these trials as varying seeding rate has had no effect on grain quality or yield. These results results did show the potential of Caparoi and Hyperno to tiller more, and Saintly and WID802 significantly less, but this did not result in more heads/m^2. More reliable data from across seasons will be needed.

2009 Durum Varietal Responses to Time of Sowing and Seeding Rate at Turretfield

Key Outcomes

- Newer varieties have a much higher yield potential than older varieties when sown early.
- Early, and mid sowing resulted in lower grain protein
- Yield most important at early and mid TOS, Quality more important at late TOS,
- Caparoi was the only variety to produce good grain quality when late sown
- Seeding rate increased yield by 2% for every extra 30 seeds sown per m2

Aim:

To evaluate the key differences amongst durum varieties in their yield and quality in response to time of sowing and seeding rate in durum growing regions of South Australia

How was it done?

Eight durum varieties were sown at four seeding rates across three different times of sowing in a split split plot design with three replicates at Turretfield in the Mid North.

- Time of sowing dates: Early (11-May), Mid (1-Jun), Late (24-Jun)
- Seeding Rate: (160, 190, 220, 250 seeds/m^2)
- Varieties: (Caparoi, Hyperno, Kalka, Saintly, Tamaroi, WID801, WID802, WID803,)

Grain yield was measured from every plot and grain quality measured from composited samples.

Grain Yield Results:

- Varieties responded differently to sowing time (Figure 3) at Turretfield in 2009.

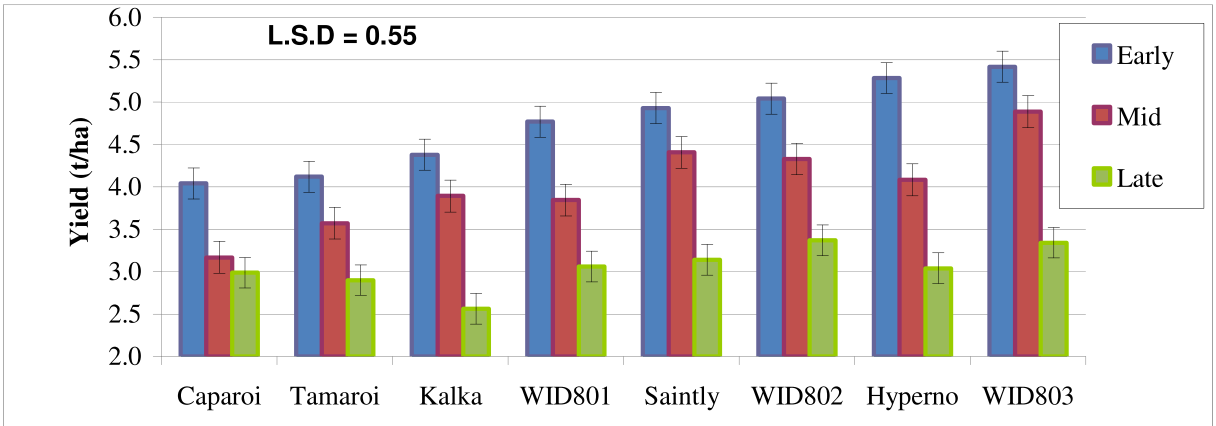

Figure 3. Grain yield data averaged across all seeding rates at different times of sowing (early, mid, and late), Turrefield.

Early Sowing (mid May):

- WID803, Hyperno, WID802, and Saintly, were the highest yielding varieties at the early sowing, followed by WID801 and then Kalka, Tamaroi, and Caparoi.
- Greatest yield potential was achieved at the earliest time of sowing.

Mid Sowing (early June):

- Moving to mid sowing changed yield rankings amongst varieties with Saintly and WID803 the highest yielding, followed by WID802, Hyperno, WID801, and Kalka all of similar yield and Caparoi significantly lower than all varieties.
- WID803 was least affected by mid sowing losing only 9% percent of its initial yield potential (from early sowing) and still yielding the same as all other varieties and higher than Caparoi and Tamaroi from the early sowing.
- Although the varieties Saintly, and WID802 had a yield reduction of 10% and 14% respectively they still maintained the same yield as WID801, Kalka, Tamaroi, and Caparoi from early sowing.
- Hyperno was found to be most sensitive to the change in sowing date, suffering a 22% yield reduction, now yielding less than WID803 and only higher than Caparoi from mid sowing.

Late Sowing (late June):

- Like Hyperno, Caparoi suffered a 21% yield reduction from early to mid sowing but its yield did not continue to be reduced at late sowing, whereas all other varieties averaged a 25% reduction. Kalka and WID803 were most sensitive to late sowing with 34% and 31% yield reductions (from mid sowing).
- With the exception of Kalka all varieties yielded similarly at the late time of sowing. Kalka yielded significantly lower than all varieties except for Caparoi and Tamaroi.

Grain Quality Results

- Sowing date effected grain quality differently amongst varieties (Figure 4 & Figure 5). A detailed table of results including return ($/ha) can be found in the attached Table 12).
- The main quality constraint for all varieties at early sowing is protein (Table 12).
- All varieties had the best quality at mid sowing. Kalka and Caparoi were the only varieties to achieve DR1 at mid sowing due to protein being above 13%.

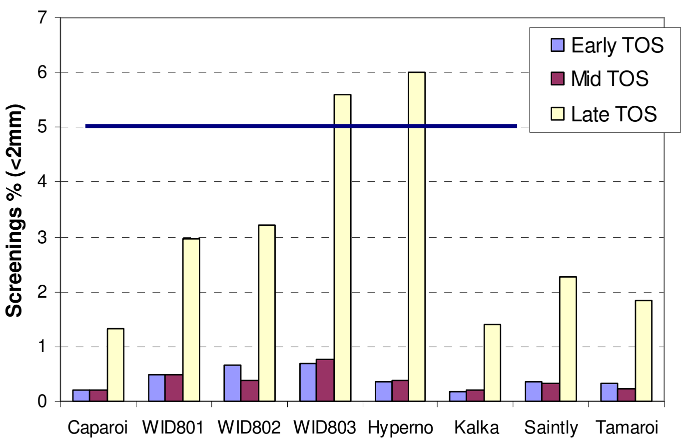

Figure 4. Effect of TOS on Screenings %(<2mm) at Turretfield 2009, line represents cut off for DR1&DR2 (5%).

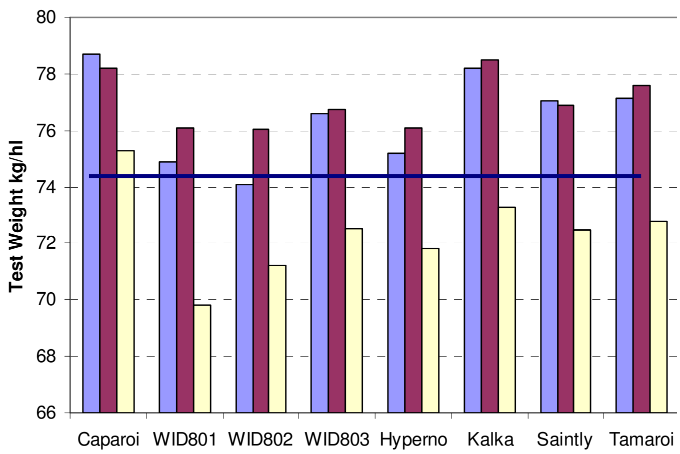

Figure 5. Effect of TOS on Test Weight (kg/hl), line represents cut off for DR1 and DR2 (74kg/hl)

- Late sowing highlighted varietal differences in grain quality. Testweight (TW) proved to be the main quality constraint at late sowing. Caparoi had a significantly higher TW than all varieties at the late TOS and more importantly being the only variety above 74kg/hL and hence reach DR1.
- All varieties produced higher screenings at late TOS. WID803 and Hyperno had large increases putting them over the 5% maximum required for DR1 and DR2

Seeding rate had no interaction with TOS or variety but proved to have a significant effect on overall yield of all durum varieties.

- Yield increased proportionally with seeding rate by about 1 – 2 % every extra 30 seeds/m2.
- Grain quality was unaffected by seeding rate (Table 11).

Table 11. 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.

Discussion:

When sown early the newer varieties (WID803, Hyperno, WID802, and Saintly) have a much higher yield potential than the older varieties Tamaroi and Kalka. 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.

The biggest factor influencing the gross return at early and mid TOS was yield (Table 12). Quality did not play a key role; it was only differences in grain protein that affected the grade received. Nitrogen was not applied to this trial to improve protein levels. Therefore, some lower yielding varieties such as Caparoi and Kalka may appear to have higher protein but this is only due to the often measured negative relationship between grain yield and grain protein (ie higher yield = lower protein). When sown early more nitrogen may be needed on the 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 with late sowing 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 inherent quality differences can then be very important. With the exception of Caparoi these results confirm previous results showing the newer varieties to be more susceptible to quality downgrades due to reduction in grain size when exposed to stress during grainfill. At late sowing Caparoi's yield was the same as all other new releases but its quality was superior being the only variety to achieve the top bin grade (DR1). Caparoi came out on top in terms of gross return at late TOS.

The seeding rate results also show that newer varieties respond similar to older varieties in that the higher plant densities are needed to maximise yield. However, seeding rate trials at other locations in 2009 showed seeding rate did not affect yield, so more research is needed in this area.

Table 12. 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