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DURUM QUALITY AND AGRONOMY FACT SHEET

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TIPS FOR ACHIEVING HIGHER DURUM QUALITY AND YIELDS

To produce the highest quality durum, growers need to develop a management plan which considers agronomic and variety selection as well as understanding the requirements of pasta manufacturers and end users.

KEY POINTS

- Durum yield potential can be influenced by sowing date and variety choice.
- Aim for a seeding rate of 220 seeds/m^2 to maximise yield and quality.
- Correct nitrogen application timing is essential. Too much applied nitrogen can result in durum setting an unattainable yield potential.
- Harvest durum at less than 12.5 percent moisture and aim for protein at 13 percent.
- To reduce chaff and whiteheads make sure harvester settings are correct.

PHOTO: BELINDA CAY

Growers should be aware of quality parameters required by manufacturers because it is a key influencer of pasta quality.

Durum for pasta

Durum wheat (*Triticum turgidum*) is the wheat used for pasta production in Australia.

In comparison to bread wheat (*Triticum aestivum*), durum is known for its extreme hardness, high protein, intense yellow colour, high vitreousness, nutty flavour, milling qualities suitable for producing semolina and good cooking qualities of the pasta. High quality durum means that manufacturers can produce semolina to make pasta which holds its shape, colour, texture and flavour when cooked. These are traits which are essential to the end consumer.

Quality parameters

Pasta manufacturers need high quality durum to produce the best semolina for pasta. Growers must be aware of quality parameters required by manufacturers because they have a major influence on the quality of pasta produced.

Generally, Australian durum (ADR1) is ideal for pasta because it produces a high semolina yield when milled and has the required physical and chemical attributes. ADR1 typically has high yellow pigment levels for a bright yellow pasta product.

Milling and standards

On receival at a mill, durum grains are cleaned to remove chaff and foreign material. Grain is then milled to remove the bran and germ. The remaining endosperm is cracked into coarse pieces, into coarse pieces, and then ground very, very finely into semolina for pasta making.

ADR1 yields high levels of top quality gluten, associated with high grain protein. This means the pasta dough has good stretch, texture and durability and is able to hold its shape when cooked.

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PHOTO: BELINDA CAY

High quality durum results in high quality semolina, which is required for optimal pasta production.

Most pasta manufacturers require durum with 13 percent protein. Occasionally they will mix at 12 and 14 percent but 13 percent is the ideal to allow for around 1 percent of lost protein when producing semolina. Other key criteria required by manufacturers to make the best quality semolina are listed in Table 1.

The lowest quality accepted for semolina and pasta production is DR3 with a minimum protein of 10 per cent. This is blended with higher quality durum to ensure a consistent product. Durum with protein that is higher than 13 percent is not necessarily desirable for semolina production; the durum will still be blended back to 13 percent before milling.

More often than not, grain traders and markets pay a premium for protein content of 13 percent or higher and for grain that meets specifications for test weight, grain screenings and hard vitreous kernels (HVK) (see Table 1).

The Grain Trade Australia Wheat Standards Checklist outlines full specifications for durum grades, some of which are shown in Table 1 (middle column) (also see Useful Resources).

Delivery issues

In recent years, delivering grain with large volumes of chaff has caused problems for millers.

The first part of the milling process involves cleaning the grain. For the past two seasons, many mills' cleaning machines have had to remove large volumes of chaff from about two-thirds of deliveries. The more chaff that must be cleaned out, the greater the loss of good grain which impacts on the mill's operational efficiency.

Correct header settings and harvest management is essential to reduce chaff

Table 1: Preferred durum specifications for semolina

PASTA MANUFACTURERS Preferred durum wheat specifications for the best quality semolina	GRAIN TRADE AUSTRALIA WHEAT STANDARDS Industry specifications that will meet ADR1 standard and make a good quality semolina	REASON BEHIND THE SPECIFICATION
At least 13 percent protein	At least 13 percent protein	Required for optimum pasta production. It produces semolina that has a uniform particle size and allows for the pasta to be physically strong and elastic.
Maximum 12 percent moisture	Maximum 12.5 percent moisture	An important parameter, particularly for processing industries and trading and will reflect grain storability.
Maximum 2 percent screenings (through 2.0 mm screen)	Maximum 5 percent screenings (through 2.0 mm screen)	Screenings are undersized grain (which can contain small foreign seeds) and is unsuitable to economically make semolina.
No material above screen chaff	0.6 percent above screen chaff	Material above the screen chaff is inconvenient for grain handlers and the processing industries and requires more extensive cleaning.
More than 90 percent hard vitreous kernels (HVK)	More than 80 percent hard vitreous kernels (HVK)	Low HVK, such as below 80 percent, can cause starchy flour production instead of semolina.
No stained grains, black point or black crease	No stained grains, black point or black crease	Fungal staining and black point creates dark flecks in the pasta sheets which are unattractive to consumers.
Test weight higher than 80 kilograms per hectolitre	Test weight above 76 kilograms per hectolitre	Poor test weight can lower the semolina yield obtained.
Falling number (FN) greater than 450 seconds	Falling number (FN) greater than 300 seconds	Weather damaged grains (FN<200) can severely affect pasta properties.
No contamination by foreign grains	Ideally, no contamination by foreign grains	Contamination of durum grain with bread wheat can increase the flour content of semolina, which affects dough performance.
No chemical contamination	No chemical contamination	Growers must follow all chemical label guidelines and monitor maximum residue limits. Pasta manufacturers have a nil tolerance.

PHOTO: BELINDA CAY

A durum sample with high levels of chaff and short straw, which may be due to poor header settings. Growers need to harvest samples which meet the end user's requirements as high chaff and straw places significant operating stress on pasta mills and can affect pasta quality.

PHOTO: BELINDA CAY

Mottled grain can be a product of durum harvesting and are undesirable to pasta manufacturers. Samples above show high quality durum with no mottling (bottom left), some grain mottling (top centre) and durum that is unacceptable for pasta production because of too much grain mottling (bottom right).

in grain and stress on millers. Growers can adjust their harvester's top sieve setting to reduce chaff.

Growers must monitor white head levels. There has been a large variation in samples taken from the same properties which may reflect how grain is being harvested. Harvesting speeds or the time of day that grain is reaped can help reduce white head levels.

Managing for protein

Grain protein content is the most important quality trait for durum. Growers must ensure they have a management plan in place which considers paddock selection, soil testing, variety selection, sowing date, plant populations, nitrogen fertiliser applications – including rate, time of application and residual soil nitrogen – and available moisture during grain filling.

Growers must consider these variables and remember that one component, such as nitrogen, cannot be used in isolation to make up for a deficiency in management practices.

Paddock selection

Durum should be grown in fertile paddocks preferably with good stored moisture. Avoid sowing into paddocks with high levels of crown rot fungus (*Fusarium pseudograminearum*). Current durum varieties are not resistant to the fungus. If it is infected, the disease develops from the base of the plant. It disrupts plant water supply in tight spring conditions, reducing the potential grain yield. If the plant is water stressed, symptoms will be exacerbated, resulting in the appearance of white heads that produce small shrivelled grain.

Crop rotations using pulses, canola, and pasture legumes are recommended to help disease and weed control. Legume break crops are ideal due to their ability to fix substantial amounts of nitrogen. High nitrogen is essential to ensure durum reaches its ideal protein potential of 13 percent.

Variety selection

Durum breeders throughout Australia are working to deliver varieties with the required quality traits. It is recommended that growers sow the newer durum varieties as they are better adapted to current growing conditions and are higher yielding. Out-classed varieties such as Tamaroi$^{\Phi}$ and Kalka$^{\Phi}$ should be avoided. Combined with correct agronomy, the preferred durum varieties in south-eastern Australia are Tjilkuri$^{\Phi}$, WID802$^{\Phi}$, Yawa$^{\Phi}$, Saintly $^{\Phi}$ and Hyperno$^{\Phi}$. These varieties have been classified as ADR by Wheat Quality Australia and meet the standards required by pasta manufacturers.

Variety performance depends on environmental conditions and agronomic management. The most frequent cause of downgrade in newer varieties have been higher than 5 percent grain screenings, grain protein below 13 percent and HVK below 80 percent resulting in mottled grain kernels.

In environments where there is an increased risk of quality downgrading from grain screenings, varieties such as Yawa$^{\Phi}$ with inherently smaller grain should be avoided, instead favour larger grained varieties such as Tjilkuri$^{\Phi}$ and Caparoi$^{\Phi}$.

In high yielding environments, newer varieties are likely to achieve a higher yield utilising the same nitrogen supply but with lower grain protein than older varieties. This means more nitrogen must be applied but it should only be applied as late as possible to minimise the potential for increased screenings.

Sowing date

Prior to sowing, soil testing is essential to help develop a nitrogen budget for the crop throughout the season. In testing the soil, it is important to test for nitrogen down at the anticipated crop's root depth.

Durum yield potential can be influenced by sowing date. The most recent durum varieties, including Tjilkuri$^{\Phi}$, WID802$^{\Phi}$ and Yawa$^{\Phi}$, showed improved yield potential at

Table 2. Comparison of durum sowing dates and yield performance*			
Variety	Early sown (May 1-15)	Mid sown (May 15-June 5)	Late sown (After June 15)
Caparoi$^{\Phi}$	98	95	103
Saintly$^{\Phi}$	107	107	105
Tjilkuri$^{\Phi}$	113	108	107
WID802$^{\Phi}$	117	112	106
Hyperno$^{\Phi}$	120	109	106
Yawa$^{\Phi}$	123	118	106
Tamaroi$^{\Phi}$	100	100	100
Tamaroi$^{\Phi}$ avg yield	4.44 t/ha	4.60 t/ha	4.31 t/ha

*Results expressed as a percentage of Tamaroi$^{\Phi}$ averaged across three years of trials at Turretfield (2009) and Tarlee (2010/11) at early, mid, and delayed sowing dates.

early (May 1-15) to mid-season (May 15-June 5) sowing dates.

Varieties with higher yield potential, such as Yawa$^{\Phi}$, WID802$^{\Phi}$ and Hyperno$^{\Phi}$, require early sowing (see Table 2). Early sowing helps maximise yield and minimises the likelihood of quality downgrades.

In comparison, Caparoi$^{\Phi}$ and Tjilkuri$^{\Phi}$ will favour later sowing as they are less likely to be downgraded due to small grain screenings. Varieties with smaller grain size should be avoided if sowing is delayed.

Nitrogen management

Applications of nitrogen at sowing or up to the start of stem elongation contribute more to crop biomass and grain yield response in comparison to later applications (booting to flowering) which facilitate greater protein responses.

Pasta manufacturers prefer 13 percent grain protein and growers can late-season top dress to produce durum that meets this target.

With application of nitrogen, yield will generally increase to a maximum point, whereas protein may continue to increase beyond this level with further application. In high yielding situations and in favourable conditions, grain protein levels in many new durum varieties may still fall below 13 percent.

While Yawa$^{\Phi}$ and Hyperno$^{\Phi}$ offer improved yields and agronomic benefits, they have been regularly reported as having low grain protein and have been downgraded. Research has found these varieties require extra nitrogen to compensate for their improved yield.

Nitrogen management tips include:

Pre-stem elongation

A key risk for durum growers is applying too much nitrogen too early. An oversupply of nitrogen prior to stem elongation can result in increased biomass, more water use, and a tendency for durum to set an unattainable yield potential (more grains/m^2). All of these factors contribute to smaller grains and increase the likelihood of downgrading from screenings later in the season, especially in dry finishes where spring conditions are less than optimal.

Durum will reach its yield potential when protein levels are between 10.5-11 percent. For growers, this means they need to calculate how much nitrogen is required before stem elongation to target a protein of 10.5-11 percent to reach an estimated maximum yield.

It is often difficult to get N requirements exact at the beginning of the season, but there are many useful resources and tools available, such as Yield Prophet and nitrogen calculators, to help growers. Soils with available nitrogen of more than 50 kilograms per hectare will generally sustain durum crops until stem elongation. Extra nitrogen for grain protein can be applied later.

Some varieties have a tendency toward higher screenings when nitrogen is applied. Application of nitrogen before stem elongaton to smaller grain size varieties such as Yawa$^{\Phi}$ and Hyperno$^{\Phi}$ can result in quality downgrading due to high screenings. Early application of large volumes of nitrogen should be avoided in these varieties.

Late season top dressing

Grain protein can be increased and grain size maintained through more appropriate nitrogen timing. Top dressing durum from booting stage to mid-flowering is the most effective time to increase protein and minimise the risk of high grain screenings.

As a rule of thumb, to increase grain protein by 1 percent, 6-8kg/ha of nitrogen must be applied for every tonne of yield potential. For example, a crop with 4t/ha yield potential needs an extra 24-32kg/ha of nitrogen applied after stem elongation to increase grain protein by 1 percent.

However, late-season application is not always easy because rain after application is needed to move nitrogen into the root zone and minimise volatilisation losses. In more marginal durum growing areas, it may be better to target an earlier application. In higher rainfall areas with sub-soil moisture and a strong chance of follow-up rain, early flowering applications may have more success.

PHOTO: BELINDA CAY

Variety choice and sowing date are the only management practices available to manage test weight. It is mostly determined by climate; particularly high temperatures during the final phase of grain fill.

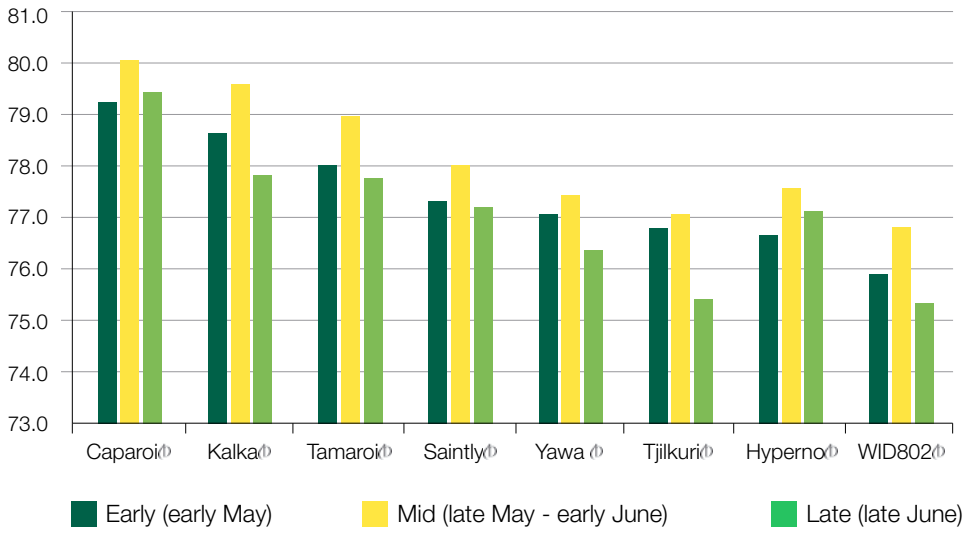
Research has found that Yawa◊ and Hyperno◊ require extra nitrogen but, to ensure quality is maintained, it should not be applied before stem elongation. In 2009-2011, the South Australian Research and Development Institute (SARDI) conducted trials where the same supply of nitrogen was applied at the onset of stem elongation and/or at flag leaf emergence. This resulted in these two varieties still not achieving 13 percent protein, but all other varieties did (Table 3).

Table 3: Comparison of grain protein (%) across different nitrogen application timings*

Nitrogen treatment	Tamaroi◊	Caparoi◊	Saintly◊	Tjilkuri◊	Hyperno◊	Yawa◊
Nil	11.9	11.9	11.9	11.6	11.3	11.4
80kg N/ha @ GS30**	13.1	13.1	12.9	12.9	12.4	12.5
40kg N/ha @ GS30** and 40kg N/ha @ GS47**	13.2	13.4	13.2	13.2	12.5	11.9
80kg N/ha @ GS47**	13.3	13.4	13.0	13.0	12.4	12.3
LSD (5%)	0.2%					

*Results expressed as a percentage of dry basis (db) and averaged across three years of trial work at Paskeville from 2009 to 2011.
The shaded treatments achieved premium grade classification based on protein for DR1.
**GS30 (onset of stem elongation), GS47 (flag leaf emergence)

Figure 1: Effect of sowing date on varietal differences in test weight*



*Test weight averaged across three years of trials at Turretfield (2009) and Tarlee (2010/11) at early, mid, and delayed sowing dates.

Seeding rate

A seeding rate of 220 seeds/m^2 is recommended to maximise yield and quality in all current durum varieties. When sowing early, seeding rates should be about 10 percent higher than bread wheat because durum has reduced tillering and relies on more plants/m^2 for shoot production, and hence grain producing heads.

Test weight

Variety choice and sowing date are the only management practices available to manage test weight. It is mostly determined by climate; particularly high temperatures during the final phase of grain fill. The best management option is to time sowing so that plant maturity corresponds with the lowest risk of adverse environmental conditions such as frost and heat stress. See Figure 1 for performance of newer durum varieties for test weight in recent trials.

FREQUENTLY ASKED QUESTIONS

What header settings and adjustments could be made to improve the end quality of durum?

Chaff can be removed or reduced by adjusting the threshing speed, drive settings, wind and quantity of grain and straw through the machine. Harvesting speeds or the time of day that grain is reaped can help reduce white head levels. Given all machines have different operating capacities it is best to refer to the user manual. One of the most important factors to consider is the moisture range at which durum is harvested, which should be no higher than 12.5 percent.

Why is weather damaged grain such an issue for pasta production?

Weather damage occurs when a grain gets wet at harvest and germination is triggered. Germination or 'sprouting' starts a complex series of chemical reactions in the grain including an increase in grain alpha-amylase, an enzyme that breaks down starch. This affects the dough quality. Pasta produced from weather damaged grain will not hold its shape when cooked.

Who are the major pasta manufacturers in south-eastern Australia?

Australian pasta is regarded as 'world leading' in terms of quality, colour, appearance, taste and cleanliness. The major pasta manufacturers in Australia are San Remo (Adelaide) and Rinoldi, which owns the Vetta brand name, (Melbourne).

Which durum varieties are best for pasta production?

Currently, the preferred durum varieties for milling in south-eastern Australia are SA varieties Tjilkuri$^{\Phi}$, WID802$^{\Phi}$, Yawa$^{\Phi}$, Saintly$^{\Phi}$ and Hyperno$^{\Phi}$, and NSW variety Caparoi$^{\Phi}$.

How is durum segregated at receival centres?

Durum is assessed for quality on receival with grain segregated according to the quality parameters of DR1, DR2 and DR3. No segregation occurs on varieties. Refer to the Grain Trade Australia Durum Quality Standards information for receival specifications (see Useful Resources).

USEFUL RESOURCES

Durum wheat production
John Kneipp
New South Wales Department of Primary Industries
www.dpi.nsw.gov.au (search for publication title)

Durum Quality Standards 2013-14 Grain Trade Australia
http://bit.ly/1fxLUg4

Crop Variety Sowing Guides
www.grdc.com.au/Research-and-Development/National-Variety-Trials/Crop-Variety-Guides

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