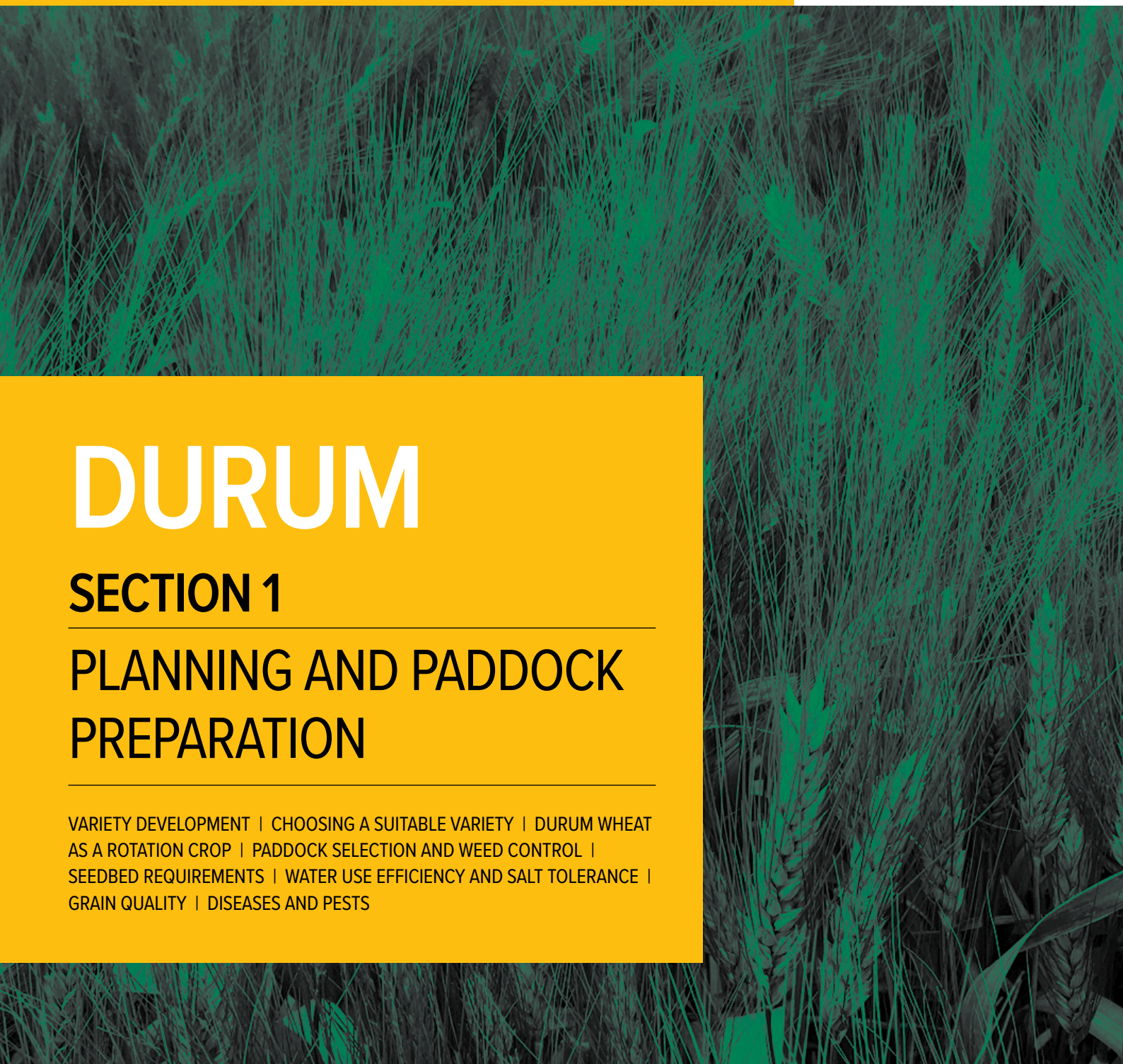
WESTERN
JUNE 2018

GRDC GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION



DURUM

SECTION 1

PLANNING AND PADDOCK PREPARATION

VARIETY DEVELOPMENT | CHOOSING A SUITABLE VARIETY | DURUM WHEAT AS A ROTATION CROP | PADDOCK SELECTION AND WEED CONTROL | SEEDBED REQUIREMENTS | WATER USE EFFICIENCY AND SALT TOLERANCE | GRAIN QUALITY | DISEASES AND PESTS

MORE INFORMATION

University of Adelaide: School of Agriculture, Food and Wine 'Durum Breeding Program': http://www.agwine.adelaide.edu.au/research/plant-genetics-breeding//

Hart Field Trial results , 2015, 'Durum Comparison, Hart Field-Site Group': http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results.pdf

GRDC National Variety Trials DBA-Aurora$^{\Phi}$: http://www.nvtonline.com.au/wp-content/uploads/2014/09/DBA-Aurora-Southern-Fact-Sheet.pdf

Planning and paddock preparation

1.1 Variety development

The release of durum wheat varieties specifically selected and produced for conditions in Western Australia will assist the uptake of this crop in the western region, as most progress is made when improved management and improved varieties are adopted together.

Development of new varieties is being undertaken nationally and the promising line DBA-Aurora$^{\Phi}$, bred by Durum Breeding Australia (DBA), has undergone limited assessment in some field trials in WA in recent years.

In 2016, researchers at the Department of Primary Industries and Regional Development (DPIRD) included it in an agronomy project investigating a range of germplasm on sodic, magnesic and dispersive soils.

Preliminary findings were that compared to grain yields for Mace$^{\Phi}$, DBA-Aurora$^{\Phi}$ achieved:

- 75 per cent (of Mace$^{\Phi}$ yield) on a sodic dispersive soil at Merredin
- 54 per cent on a sodic dispersive soil at Katanning
- 32 per cent on a sandy soil at Merredin
- 100 per cent (the same as Mace$^{\Phi}$) on a saline soil at Nangeenan.

(SOURCE: Dr Darshan Sharma, DPIRD, 2017 – unpublished)

For more information about this trial, contact DPIRD Genetic Improvement project manager Dr Darshan Sharma.

DBA is a national initiative between GRDC, the University of Adelaide (UA) and NSW Department of Primary Industries (NSWDPI). It was formerly the Australian Durum Wheat Improvement Program (ADWIP), which was set up in 2007.

Funded by GRDC and pasta maker San Remo Macaroni Pty Ltd, ADWIP had southern and northern research nodes to breed varieties suited to local conditions.[1]

Since 2010, Dr Jason Able has run the southern node breeding program of DBA at UA and the northern node breeding operation is led by Dr Gururaj Kadkol, at NSWDPI.

DBA-Aurora$^{\Phi}$ can be considered a 'step-change' variety release from DBA and breeders are continuing to develop durum wheat lines that will provide a significant boost to national industry expansion.

A major consideration about whether to grow durum wheat each season has been the fear of crop losses from crown rot (caused by the fungus *Fusarium pseudograminearum*).

The susceptibility of durum wheat to crown rot is exacerbated by stubble retention, high levels of cereal cropping in rotations and zinc (Zn) deficiency in some soils.

Varietal reactions are confounded by the timing of water stress, presence of another closely related pathogen (*F. culmorum*) that causes Fusarium head blight (FHB), soil type and complexity of the genetics for resistance.

Some advanced breeding lines are showing reduced susceptibility to crown rot and additional improvements are expected to be made in coming years through fast-tracked pre-breeding research.

1 The University of Adelaide (2016) School of Agriculture, Food and Wine — Durum Breeding Program, http://www.agwine.adelaide.edu.au/

Diversity in parental genetics and short generation intervals are integral to the breeding program. DBA imports material from across the world to incorporate diversity into Australian breeding material.

Materials have come from as far afield as the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, International Centre for Agricultural Research in the Dry Areas (ICARDA) in Syria and Società Produttori Sementi in Italy. More recently, DBA's southern node has started investigating germplasm from Canada and the USA.[2]

Worldwide, molecular markers play an important role in today's breeding programs. DBA is no exception and is collaborating with fellow researchers to develop and implement marker-assisted selection (MAS) at UA.

1.2 Choosing a suitable variety

From 2007 to 2015, several new durum wheat varieties were released in Australia. These included DBA-Aurora$^{\Phi}$, Hyperno$^{\Phi}$, Saintly$^{\Phi}$, Tjilkuri$^{\Phi}$, Yawa$^{\Phi}$ and WID802$^{\Phi}$ in the southern region and Caparoi$^{\Phi}$, EGA Bellaroi$^{\Phi}$, Jandaroi$^{\Phi}$, Yallaroi$^{\Phi}$ and Wollaroi in the northern region. Past trials in WA have found the mid-season varieties Yallaroi$^{\Phi}$, Kalka, EGA Bellaroi$^{\Phi}$ and Arrivato may be suitable for local conditions and may be best sown first in a wheat program – but not before May. These trials also indicated the short season variety Wollaroi should be sown later, but not after mid-June.[3] The commonly-grown southern region varieties Hyperno$^{\Phi}$ and Saintly$^{\Phi}$ may also have good adaptation in areas suitable for growing durum in WA.

Key characteristics of some of these older varieties – and some more recent lines – that may have potential to be grown in WA are outlined below.

DBA-Aurora$^{\Phi}$

Figure 1: *DBA-Aurora$^{\Phi}$ was released in 2014 and has good grain size and improved disease resistance.*

(SOURCE: University of Adelaide)

- Released 2014 in the southern region by DBA
- Significant improvements in grain size, screenings and disease resistance
- Very high yielding

MORE INFORMATION

National Variety Trials 'Durum wheat trials, WA' 2009 and 2010: https://www.nvtonline.com.au/nvt-results-reports/?nocollapseomatic=1#lat=-30.77&lng=121.50&zoom=5

Queensland Department of Agriculture and Fisheries 'Durum Wheat in Queensland': https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/wheat/durum-wheat

New South Wales Department of Primary Industries 'Primefacts': http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

NSWDPI 'Durum Wheat Production': http://www.nvtonline.com.au/wp-content/uploads/2013/03/Crop-Guide-NSW-Durum-Wheat-Production.pdf

Wheat Quality Australia (for classification): http://wheatquality.com.au/classification/how-it-works/classes/

GRDC-DPIRD Wheat Variety Sowing Guides for Western Australia: https://www.agric.wa.gov.au/grains-research-development/2018-wheat-variety-sowing-guide-western-australia

2 The University of Adelaide (2016) School of Agriculture, Food and Wine — Durum Breeding Program, http://www.agwine.adelaide.edu.au/

3 Anderson, W.K (2004) Development of the Durum Industry in the Western Region, http://finalreports.grdc.com.au/DAW703

FEEDBACK

- Limited trials undertaken in WA in 2016 as part of an agronomy project investigating a range of germplasm on sodic, magnesic and dispersive soils
- Preliminary findings were that compared to grain yields for Mace$^{\phi}$, DBA-Aurora$^{\phi}$ achieved:
  - 75 per cent (of Mace$^{\phi}$ yield) on a sodic dispersive soil at Merredin
  - 54 per cent on a sodic dispersive soil at Katanning
  - 32 per cent on a sandy soil at Merredin
  - 100 per cent (the same as Mace$^{\phi}$) on a saline soil at Nangeenan.

(SOURCE: Dr Darshan Sharma, DPIRD, 2017 - unpublished)

For more information about this trial, contact Dr Darshan Sharma at DPIRD.

Yawa$^{\phi}$

Figure 2: *Yawa$^{\phi}$ is a very high yielding durum wheat variety and was released in 2012.*

(SOURCE: Jason Able, University of Adelaide)

- Released 2012
- Very high yielding
- Good grain quality characteristics
- May be suited to parts of WA but check its classification through Wheat Quality Australia at http://wheatquality.com.au/classification/how-it-works/classes/.

WID802Φ

Figure 3: *The high yielding variety WID802Φ has good grain quality traits.*

(SOURCE: Jason Able, University of Adelaide)

- Released 2012
- Very high yielding
- Good grain quality characteristics
- May be suited to parts of WA but check its classification through Wheat Quality Australia at http://wheatquality.com.au/classification/how-it-works/classes/.

TjilkuriΦ

Figure 4: *Released in 2010, the durum wheat TjilkuriΦ had improved semolina quality traits compared to older varieties.*

(SOURCE: GRDC)

- Released 2010
- A slightly later maturing variety
- Consistently higher yield and quality characteristics — including semolina colour — than older varieties
- Compact stature — less likely to lodge than HypernoΦ
- May have suitability for parts of WA but check its classification through Wheat Quality Australia at http://wheatquality.com.au/classification/how-it-works/classes/.

FEEDBACK

Hyperno$^{\Phi}$

Figure 5: *Hyperno$^{\Phi}$ has demonstrated high and stable grain yields across SA and NSW durum growing regions and performs particularly well in higher yielding environments. It may be suited to durum growing areas in WA.*

(SOURCE: AGT)

- Released 2008
- Mid-season maturing variety
- Consistently high and stable grain yields in SA and NSW
- Very good semolina and pasta making quality
- ADR classification
- Excellent stem, stripe and leaf rust resistance
- Very susceptible to crown rot
- May suit potential durum production areas of WA.

(SOURCE: AGT)

Saintly$^{\Phi}$

Figure 6: *Saintly$^{\Phi}$ is an early maturing durum that is well suited to southern production zones that risk having a sharp finish to the growing season. It may be suited to durum growing areas in WA.*

(SOURCE: AGT)

- Released 2008
- Early maturing variety
- High relative yields in tough finishes to the season
- Tip-awned, allowing for hay production
- Very good semolina and pasta making quality
- ADR quality classification in SA and VIC
- Very susceptible to crown rot.

(SOURCE: AGT)

FEEDBACK

Caparoi[Φ]

- Released 2010, primarily for northern Australia
- But may be suitable for central and southern parts of WA on neutral and alkaline soils (not saline or acidic)
- High-yielding, mid-season, semi-dwarf variety
- High yield performance noted in southern Queensland
- Improved dough strength relative to EGA Bellaroi[Φ]
- High level of resistance to stem rust, stripe rust and yellow leaf spot
- Moderately resistant-moderately susceptible to leaf rust
- Moderately tolerant to root lesion nematodes (RLN)
- Very susceptible to crown rot
- Good resistance to lodging and shattering.

Jandaroi[Φ]

- Released 2009
- Bred for NSW and Queensland but may be suited to parts of WA where durum can be grown, typically on neutral to alkaline soils (not saline or acidic)
- Superior semolina and pasta quality
- A bright, clean, yellow appearance and no discoloration
- High level of resistance to stem rust, leaf rust
- Very susceptible to crown rot.

EGA Bellaroi[Φ]

- Released 2003
- The current major variety grown in Australia
- Has been trialled in WA eastern grainbelt, where it showed some suitability
- Grain yield similar to, or better than, Yallaroi[Φ] and Wollaroi[Φ] in northern NSW
- Grain protein consistently higher than other current commercial varieties
- Exceptional pasta-making quality
- Resistant-moderately resistant to stem and leaf rust
- Resistant to yellow leaf spot and common root rot
- Moderately tolerant to RLN
- Very susceptible to crown rot
- Good black point and lodging resistance.

FEEDBACK

1.2.1 Future breeding directions

DBA aims to continue developing and commercially releasing export quality durum wheat varieties with traits including:

- Higher grain yield
- Improved adult plant resistance for the three major cereal crop rusts and yellow leaf spot
- Complete resistance to flag smut and common bunt (also known as stinking smut)
- Grain size higher than 45 grams
- Resistance to pre-harvest sprouting and enhanced quality characteristics.

The resistance of durum wheat varieties grown in Australia to major diseases and other conditions affecting these crops is outlined in further detail in Table 1.

Table 1: Levels of resistance to diseases and other conditions (durum varieties compared to a bread wheat variety).

	Durum wheats				Bread wheat
	Jandaroi[Φ]	**Caparoi**[Φ]	**Hyperno**[Φ]	**EGA Bellaroi**[Φ]	**Kennedy**[Φ]
Disease					
Yellow spot	MR-MS	MR	MS	MR	MR
Crown rot	VS	VS	VS	Vs	MS-S
Common root rot	MR	R-MR	R-MR	MR	MS
RLN tolerance[A]	MI	MT-MI	MT-MI	MI	MI
RLN resistance[A]	MS-S	MS	MR	MR-MS	S-VS
Stem rust	R	R-MR	R	R-MR	MS
Leaf rust	MR	MR-MS	R-MR	MR-MS	MS
Stripe rust	MR	MR	MR	MR	MS
Agronomy					
Resistance to black point[B]	MR-R	MR-MS	MR-MS	R-MR	R
Resistance to lodging	MR	MR	MR-MS	R	MR
Resistance to shattering	MR	R-MR	R-MR	R	R-MR
Resistance to sprouting	R-MR	MR-MS	MR-MS	MS	S

R = Resistant MR = Moderately resistant MS = Moderately susceptible S = Susceptible VS = Very susceptible T = Tolerant MT = Moderately tolerant I = Intolerant VI = Very intolerant.

[A]Root lesion nematode (RLN) tolerance applies to *Pratylenchus thornei* and not *P. neglectus*; tolerant varieties yield well in the presence of RLN; resistant varieties prevent RLN reproduction.

[B]Back point will not cause a reduction in yield but may result in grain receiving a lower quality classification.

1.2.2 Variety comparison trial

A major comparison trial of existing and new durum wheat varieties was set up in 2015 at the Hart Field Trial site, in SA, to assess performance against industry standards.

This provides recent data for some of the lines that show potential for WA conditions and it found average grain yield for all durum varieties was 3.07 tonnes per hectare, with a range of 2.88 t/ha to 3.22 t/ha. There was a variation of only 0.34 t/ha between yields of all seven varieties trialled, as shown in Table 2.[4]

4 Hart Field Trial results (2015) Durum Comparison, Hart Field-Site Group (2015), http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results.pdf

FEEDBACK

Table 2: Grain yields and quality results from the Hart Field Trial Site in South Australia in 2015.[5]

Variety	Grain yield t/ha	% of site average	Protein %	% of site average	Test Weight kg/hL	% of site average	Screenings %	% of site average
Caparoi$^{\Phi}$	3.03	99	12.2	103	79.7	102	1.8	46
Tamaroi	2.88	94	11.8	100	78.9	101	2.1	55
Saintly$^{\Phi}$	2.98	97	11.9	101	77.9	100	2.3	58
Hyperno$^{\Phi}$	3.01	98	11.8	100	76.9	98	7.5	195
DBA-Aurora$^{\Phi}$	3.22	105	11.4	97	77.4	99	2.7	69
Tjilkuri$^{\Phi}$	3.11	102	12.2	103	77.9	100	3.9	101
Yawa$^{\Phi}$	3.22	105	11.5	97	77.9	100	6.8	176
Site Average	**3.07**	**100**	**11.8**	**100**	**78.1**	**100**	**3.9**	**100**
LSD (P≤0.05)	0.21		0.4		1.2		1.2	

Test weight values of varieties trialled were high and only two varieties (Hyperno$^{\Phi}$ and Yawa$^{\Phi}$) exceeded a minimum 5 percent screenings. All varieties were above the minimum test weight value of 76 kg/hL. Similar to trials in 2014, Caparoi$^{\Phi}$ had the highest test weight followed by Tamaroi.

Seeding date was May 6 and fungicides and herbicides were applied as necessary to keep the crop canopy free of disease and weeds.

All plots were assessed for grain yield, protein, test weight and screenings with a 2.0 millimetre screen.

The highest yielding varieties were DBA-Aurora$^{\Phi}$, Yawa$^{\Phi}$, Tjilkuri$^{\Phi}$ and Caparoi$^{\Phi}$. Achieving target protein is key to growing durum wheat and the trial showed varieties ranged from 11.4 to 12.2 percent, averaging 11.8 percent. Tjikuri$^{\Phi}$ and Caparoi$^{\Phi}$ had the highest protein levels at 12.2 percent.

Screening levels across the trial were generally low, with the exception of Hyperno$^{\Phi}$ and Yawa$^{\Phi}$.[6]

1.3 Durum wheat as a rotation crop

Durum wheat varieties are relatively resistant to the Root Lesion Nematode (RLN) *Pratylenchus thornei*, compared to other winter cereal crops.[7]

This increases their value in rotations to reduce nematode numbers in the soil.

However, durum wheat crops will tend to more rapidly build up crown rot inoculum, which can negatively affect subsequent winter cereal crops.

A robust crop rotation should be planned across several seasons if successful crops of durum wheat are to be produced.

It is advisable to sow durum wheat as the first cereal crop after a non-cereal species and to avoid growing successive durum crops.

Rotations of durum wheat with non-cereal species, including pulses, canola and pasture legumes, can provide benefits of:

- Controlling root disease, especially crown rot
- Providing for the biological fixation of nitrogen (N) by legumes
- Controlling weeds and contaminant crop species
- Aiding in herbicide group rotations.

5 Hart Field Trial results (2015) Durum Comparison, Hart Field-Site Group (2015), http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results.pdf

6 Hart Field Trial results (2015) Durum Comparison, Hart Field-Site Group (2015), http://www.hartfieldsite.org.au/media/2015%20Trial%20Results/2015_Hart_Trial_Results.pdf

7 Kneipp, J (2008) Durum Wheat Production, NSW Department of Primary Industries, http://www.nvtonline.com.au/wp-content/uploads/2013/03/Crop-Guide-NSW-Durum-Wheat-Production.pdf

1.4 Paddock selection and weed control

Durum wheat is best grown where a reliable harvest of high protein (more than 13 percent), plump hard vitreous grain can be achieved.

It is recommended to select paddocks that are fertile, store good levels of water, and receive reliable in-crop rainfall.

Durum wheat should not be sown into paddocks that are known to carry high levels of crown rot inoculum. A suitable rotation should be practiced to reduce crown rot inoculum levels.

Ground preparation is the same as for bread wheat.

Adequate weed control is vital and ideally should eliminate all weeds and volunteer plants of bread wheat, barley and/or other crop species.

This can be achieved by controlling weeds in preceding crops and during fallow periods, rotating crops, growing competitive durum wheat crops and targeted use of registered herbicides at full label rates.

1.5 Seedbed requirements

Quality seed for planting is essential. It is advised to use seed that has a high germination percentage, is large and plump, is genetically pure and free of all contaminants, such as weed seeds and impurities of other winter cereals (particularly bread wheat and barley).

Seed is best treated with an appropriate fungicide to avoid head disease (such as smuts and bunts) and leaf diseases (such as stripe rust).

Registered fungicide actives for wheat/durum wheat in WA include:

- Tebuconazole
- Propiconazole
- Flutriafol
- Metalaxyl-M
- Fluxapyroxad
- Sedaxane
- Ipconazole
- Fluquinconazole
- Prothioconazole
- Penflufen
- Triticonazole
- Triadimenol
- Difenoconazole
- Thiram
- Carboxin.

It is recommended to plant seed into a cultivated or chemically prepared seedbed at a depth of about 25-35mm as durum wheat has a short to medium coleoptile length and preferably to use minimum disturbance equipment with a press wheel adjusted to soil and moisture conditions.

Seeding rates and sowing times will vary from region to region and it is best to check with local advisers and seek local information.

FEEDBACK

MORE INFORMATION

GRDC 'Ground Cover Water Use Efficiency': http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-54/Tracking-wateruse-efficiency

1.6 Water use efficiency and salt tolerance

Plant breeders in the DBA project, a collaboration between NSWDPI, The University of Adelaide (UA) and researchers at CSIRO Plant Industry (in Canberra and WA), are developing water use efficient and salt tolerant durum wheat lines to increase yields in current production areas, as well as in new environments.[8]

Researchers are improving water use efficiency by trying to combine several traits: high transpiration efficiency, long coleoptiles and early vigour.

Using 50 years of climate data and computer simulation, they have found combining high transpiration efficiency and early vigour is likely to make durum wheat much more suitable for growing in all cropping areas of Australia.

Elite durum varieties have low transpiration efficiency, but the research team has found a highly transpiration-efficient durum line to cross with these. This will give the plants a water use efficiency trait similar to that of new bread wheat varieties.

The team is also introducing alternative dwarfing genes from European durum wheats into commercial varieties. These genes restrict plant height, but allow the expression of long coleoptiles.

Longer coleoptiles provide some insurance that the shoot reaches the soil surface, even when deep sowing is required because of receding topsoil moisture, or when there is uneven sowing depth.

CSIRO and NSWDPI are also developing salt tolerant durum wheat lines, to allow durum to be grown in areas affected by subsoil salinity. This follows a search of the Australian Winter Cereal Collection (AWCC) in Tamworth that revealed ancient Persian durum wheats with the ability to exclude salt from their roots.

Durum wheat has traditionally been more susceptible to moderately saline soils than bread wheat.

The team has identified two major genes that confer the salt tolerance and a molecular marker has been found for one of these genes. There is ongoing research to find a marker for the other, with the aim of breeding a commercial variety of durum wheat that is tolerant of saline soils.

1.7 Grain quality

Grain quality is key to obtaining premium prices for durum wheat.

Downgrading at receival points might occur if grain contains mottling, black point or weather damage.

The most frequent causes of downgrades in newer durum wheat varieties include grain with:

- Higher than 5 percent grain screenings
- Protein below 13 percent
- Hard-vitreous kernels below 80 percent – resulting in mottled kernels.[9]

In environments where there is an increased risk of quality downgrading from grain screenings, it is advisable to use larger grained varieties, such as Tjilkuri$^{\Phi}$ and Caparoi$^{\Phi}$.

In high yielding environments, new varieties tend to be more likely to achieve a higher yield using the same N supply but have potential to produce lower grain protein than some older varieties.

This means more N may be needed, but is best applied as late as possible to minimise the potential for increasing screenings.

8 GRDC (2005) Tracking Water-Use Efficiency, GRDC Groundcover Issue 54, http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-54/Tracking-wateruse-efficiency

9 Department of Agriculture and Fisheries (2012) Durum Wheat in Queensland, Queensland Department of Agriculture, Fisheries and Forestry, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/wheat/durum-wheat

FEEDBACK

1.8 Diseases and pests

Major diseases to affect durum wheat crops include: leaf, stem and stripe rust; crown rot; leaf spot diseases; and fusarium head blight. More information about managing diseases can be found in Chapter 5. Insects are not typically a major problem in WA winter cereals, but several pests can cause serious damage to wheat crops in some seasons.

The significance of particular pests to wheat growth and yield varies from season to season and within farming systems. More information can be found in Chapter 7.

Comprehensive guidelines about identification and management of pests in WA cropping systems are available through the GRDC-Department of Primary Industries and Regional Development (DPIRD) MyPestGuide app at https://mypestguide.agric.wa.gov.au/#/

This hub contains information about 200 crop and grain storage pests, beneficial and biological control agents and biosecurity pest threats specific to WA.

A key feature of the app is that it enables users to send pest reports and photos direct to entomologists at DPIRD for diagnosis and management advice.