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GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

DURUM

SECTION 2

PLANTING

OVERVIEW | SEED GERMINATION AND VIGOUR | TIME OF SOWING | MATURITY | SOWING RATES | SOWING DEPTH | ROW SPACING | MANAGING CROWN ROT | PRE AND POST-EMERGENT HERBICIDES | CANOPY MANAGEMENT

MORE INFORMATION

GRDC 'Durum Quality and Agronomy Fact Sheet': www.grdc.com.au/GRDC-FS-Durum

GRDC Western 'Wheat' and Northern 'Durum' GrowNotes™: www.grdc.com.au/GrowNotes

Planting

2.1 Overview

Durum wheat seed size is, on average, 20 percent bigger than bread wheat seed size and it is advised to increase typical seeding rates used for bread wheat by this amount when planting durum wheat varieties.[1]

The target durum wheat plant density across southern Australia ranges from 120 to 200 plants per square metre, depending on rainfall zone, with about 120-150 plants/m^2 expected to be needed for optimal establishment in Western Australian conditions.[2]

A reduced germination percentage, or a late sowing, may necessitate increasing seeding rates.[3]

Ground preparation for durum wheat is similar to that for growing bread wheat.

Conventional sowing equipment can be used, but may have to be adjusted for the bigger seed size.

Adequate cultivation and/or herbicide application should eliminate volunteer plants of bread wheat, barley and other crop/weed species.

It is advised to treat durum wheat seed with an appropriately registered product just before sowing to control 'damping-off' from root diseases, smut or bunt.

But it is worth nothing that some chemical constituents can reduce viability and seedling vigour if these remain in contact with the seed for any length of time.

2.2 Seed germination and vigour

It is recommended to use sound seed that is clean and true to varietal type.

Seed should be high quality and preferably sourced from certified seed stocks, with a germination test result of more than 80 percent.

Before harvesting any on-farm seed stocks for the following season, ensure control of rogue 'off-types' and contaminant crop and weed plants/seeds.

Seed grain retained on-farm for sowing in subsequent seasons is ideally stored in clean silos with aeration capacity and ability to be sealed for insect control.

Durum wheat seed should be kept dry and as cool as possible to help maintain high viability for the following season.

2.2.1 Seed treatments

Registered seed dressing and in-furrow fungicides are particularly important for early sown and long-season wheat crops and, in some cases, can replace the need for a foliar spray before flag leaf emergence.

1 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

2 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

3 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

It is advisable to treat durum wheat seed with an appropriately registered disease control product just prior to sowing for control of some diseases. See Section 5 for more information.

Commercial durum wheat varieties are highly resistant to some loose smut, flag smut and stinking smut fungi.

Seed treatment can offer protection to establishing seedlings from damping-off diseases.

Registered seed fungicide actives for durum wheat include:

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

It is recommended to check label rates and application details closely, as some chemical constituents can reduce viability and seedling vigour if they remain in contact with the seed for a significant period of time.[4]

Some fungicide seed dressings also have potential to reduce coleoptile length and cause 'silly seedling syndrome' where leaves grow under the soil surface but do not emerge.

MORE INFORMATION

GRDC '2013 Update Paper: Wheat Variety Response to Dry Sowing and Seeding Depth': http://giwa.org.au

2.3 Time of sowing

Durum wheat yield potential can be influenced by sowing date.

The most recent durum varieties, including DBA-Aurora⍉, Tjilkuri⍉, WID802⍉ and Yawa⍉, have shown improved yield potential when sown early (May 1-15) compared to mid-season (May 15-June 5) sowing dates.

Varieties with higher yield potential, such as Yawa⍉, WID802⍉ and Hyperno⍉, require early sowing in most Australian grain growing areas.

This helps maximise yield and minimise the likelihood of quality downgrades.

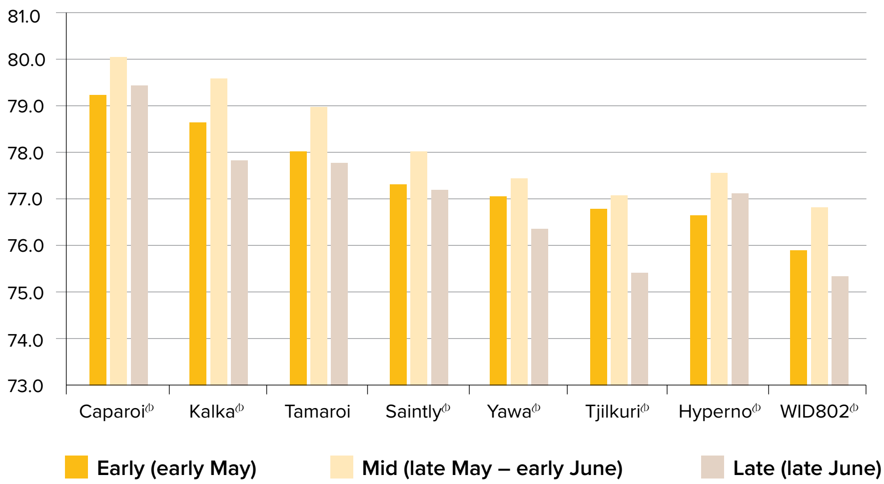
In comparison, Caparoi⍉ and Tjilkuri⍉ tend to favour later sowing dates in many areas, as these lines are less likely to be downgraded due to small grain screenings. Varieties with smaller grain size should be avoided if sowing is delayed.

Optimum sowing date will depend on the maturity rank of the variety, latitude of the sowing site and topographic aspect (including north/south facing slope and elevation).

The effect of time of sowing on aspects of durum wheat grain quality (in test weights) is shown in Figure 1.

4 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

Figure 1: *Effect of sowing date on varietal differences in test weight.*[*5]



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

The time of sowing of a particular variety is a critical factor in crop risk management. Growers in WA are advised to aim for a balance to minimise the combined risks of frost damage around flowering and grain filling, moisture stress at this time and rain or storm damage just prior to harvest.

Crops sown earlier than optimal timing can be exposed to an elevated frost risk. Those sown later than the optimal period could encounter high moisture or heat stress and/or harvest spoilage/quality issues.

These risks cannot be eliminated, but minimisation is possible using a range of management practices.

2.4 Maturity

There is a relatively small range of crop maturity in commercially available durum wheat varieties, compared with bread wheat varieties.[6]

Durum wheat lines are typically similar in maturity to the fastest-maturing bread wheats. This is an important consideration when managing frost risk, but can limit opportunities to exploit early planting opportunities.

Extended flowering could reduce the risk of pollination failure caused by frost or extended moist weather.

The time difference in reaching full maturity between the early-flowering and late-flowering tillers tend to be small. Therefore, early heads are not likely to be ripe for many days ahead of later heads.

Harvesting should not be delayed significantly.

MORE INFORMATION

GRDC 'Cereal Growth Stages Guide': www.grdc.com.au/GRDC-Guide-Cereal-Growth-Stages

5 GRDC '2013 Update Paper: Wheat Variety Response to Dry Sowing and Seeding Depth': http://giwa.org.au

6 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

2.5 Sowing rates

Durum wheat seeding rates should be at least 10 percent higher than those typically used for bread wheat varieties to allow for bigger seed size.[7]

If sowing early in the season, seeding rates can be further increased — by about 10 percent — to allow for reduced tillering in durum wheat varieties and a reliance on more plants/m^2 for shoot production and, therefore, grain producing heads.[8]

Sowing rate can be considered a risk management tool.

Dense stands of plants tend to produce few tillers per plant (i.e. the primary and a few secondary tillers). Stands at a reduced density tend to have plants that produce a larger number of tillers per plant.

Such reduced-density stands typically have more flexibility in response to changing growing conditions (such as if moisture is limiting). Fewer tillers are initiated, but if seasonal conditions improve additional tillers may develop.

2.6 Sowing depth

In a well-prepared seedbed, the recommended sowing depth is between 25-35 mm.

Current durum wheat varieties are semi-dwarf lines, which means the length of the coleoptile is reduced and it cannot penetrate deeper in the soil.

Research has shown sowing large seeds (of at least 35-38 milligrams) at a depth of 25-35 mm into marginal moisture can lift plant establishment for a range of wheat varieties — even those with shorter coleoptiles.[9]

Large seed tends to produce more vigorous seedlings that can typically better tolerate early season stresses.

In a season with a dry start, deep sowing into moisture is a tool that can ensure crops are established in the optimal sowing window.

While deeper sowing can sometimes reduce crop germination percentage, the yield from the earlier sowing may offset yield losses associated with sowing later in the season.

Deep sowing into moisture may help ensure the wheat crop hits the optimum flowering window while also assisting with the logistics of a large seeding program.

Several factors influence the capacity of wheat seed to emerge from depth, including:

- Coleoptile length
- Seed size
- Soil conditions, including temperature
- Fungicide treatments
- Herbicides, such as trifluralin.

Sowing varieties with short coleoptile lengths too deep can cause poor establishment, as the shoot will emerge from the coleoptile underground and may never reach the soil surface, as illustrated in Figure 2.[10]

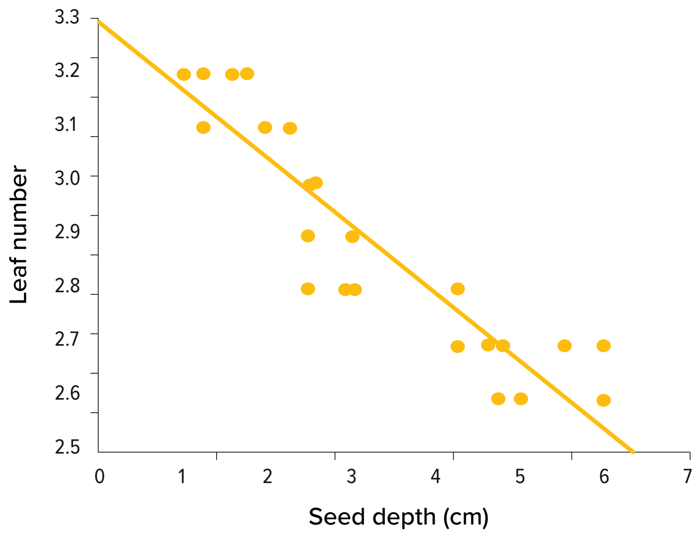
7 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

8 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

9 DAFWA (2014) Size Does Matter for Deep Sown Wheat, https://www.agric.wa.gov.au/news/media-releases/size-does-matter-deep-sown-wheat

10 Anderson, W.K. The Wheat book: principles and practice, 2000, http://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1005&context=bulletins

Figure 2: *Impact of depth of sowing on seedling establishment.*[11]



In 1990 trials, grain yield was reduced by a minimum of 10 percent when short coleoptile wheat lines were sown deeper than 5 cm.

Coleoptile length is influenced by several factors, including variety, seed size, temperature, soil moisture and some fungicide dressings and pre-emergent herbicides.

2.7 Row spacing

Choice of wheat row spacing is a compromise between ease of stubble handling, effective use of pre-emergent herbicides, managing weed competition and crop yield.

The impact of row spacing on cereal yield varies depending on growing season rainfall, time of sowing and potential yield of the crop.

The higher the yield potential, the greater the negative impact of wider rows on wheat yield in WA, as shown in Table 1.

Table 1: Benefits and costs of a wider row spacing in wheat.[12]

Benefits	Costs
Easier stubble management at sowing and faster sowing speeds.	Lower yields.
Lower fuel and machinery costs during sowing.	Increased weed competition.
Subsequent crops can be sown on the interrow.	Slower canopy closure (more weeds and soil evaporation).
Higher rates of trifluralin can be used without crop damage.	Fertiliser toxicity if seeding pattern not altered.
Less soil disturbance and greater moisture conservation for grain filling in some seasons and lower rainfall areas.	Higher potential for lodging.

MORE INFORMATION

GRDC '2014 Update Paper: Aim for Narrowest Possible Row Spacing': https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/05/Aim-for-the-narrowest-possible-row-spacing

11 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

12 Scott, B, Martin, P, Riethmuller, G (2013) Row spacing of winter crops in broad scale agriculture in southern Australia, Graham Centre Monograph No. 3, NSW Department of Primary Industries, Orange, www.grahamcentre.net

Wider row spacing tends to reduce the impact of soil treated with pre-emergent herbicides being thrown from one row into an adjacent row — where it might reduce crop emergence.

Soil throw distance increases with the square of speed. For example, doubling the speed of planting will increase soil throw distance four times.

Research and experience has found speed can increase by about 1.4 times if row spacing is doubled, as highlighted in Table 2.

Table 2: Impact of row spacing on wheat yield in the absence of stubble in WA trials (yield from 18 cm row spacing taken as 100 percent).[13]

Number of trials	Row spacing (cm)					
	9	18	27	36	45	54
7	-	100	92	94	-	-
19	115	100	95	90	77	75
16	112	100	93	-	-	-
Average yield response (%)	+14	-	-7	-8	-23	-25
kg grain/ha per cm change in row spacing	+24	-	-11	-5	-23	-5

There is research showing wide rows can reduce grain yield, especially in higher rainfall areas.

In an Australia-wide review of row spacing trials, researchers found that at average wheat yields of 2 tonnes per hectare, widening planting rows to 36 cm reduced yields to 1.86 t/ha.[14]

At average yields below 0.7 t/ha, widening the row space beyond 18 cm increased estimated grain yield.[15]

For example, at average yields of 0.5 t/ha, doubling the row spacing to 36 cm increased yield to 0.52 t/ha — reflecting the moisture saving benefits of wider rows in drier regions.

WA wheat trials comparing row spacing from 9-54 cm found wider spacing decreased grain yield.

This research found an average 8 percent reduction in yield for each 9 cm increase in row spacing from 9-54 cm.[16]

Yield response to row spacing is also influenced by time of sowing.

These trials at Meckering examined the impact of row spacing and two sowing times (19 May and 14 June) on wheat yield, as shown in Figure 3.[17]

13 Scott, B, Martin, P, Riethmuller, G (2013) Row spacing of winter crops in broad scale agriculture in southern Australia, Graham Centre Monograph No. 3, NSW Department of Primary Industries, Orange, www.grahamcentre.net

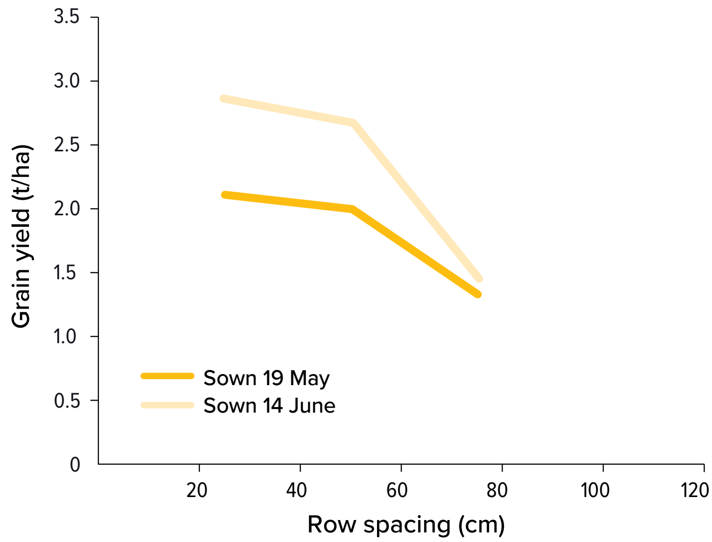
14 Scott, B, Martin, P, Riethmuller, G (2013) Row spacing of winter crops in broad scale agriculture in southern Australia, Graham Centre Monograph No. 3, NSW Department of Primary Industries, Orange, www.grahamcentre.net

15 Scott, B, Martin, P, Riethmuller, G (2013) Row spacing of winter crops in broad scale agriculture in southern Australia, Graham Centre Monograph No. 3, NSW Department of Primary Industries, Orange, www.grahamcentre.net

16 GRDC (2011) Fact Sheet A Systems Approach to Row Spacing, GRDC https://grdc.com.au/resources-and-publications/all-publications/factsheets/2011/02/crop-placement-and-row-spacing-southern-fact-sheet

17 GRDC (2011) Fact Sheet A Systems Approach to Row Spacing, GRDC https://grdc.com.au/resources-and-publications/all-publications/factsheets/2011/02/crop-placement-and-row-spacing-southern-fact-sheet

Figure 3: *Impact of row spacing and time of sowing on wheat yield at Meckering, WA.*[18]



This trial found there was a higher rate of yield reduction with wide rows in later-sown crops, which had less time for canopy development.

2.7.1 Row spacing and fertiliser

In terms of fertiliser use and row spacing, it has been found that the bulk of fertilisers used in WA can damage germinating seeds if applied in close proximity and in a concentrated band.

Figure 4: *Use of wider row spacing and no-tillage seeding systems can result in more fertiliser being placed in the seeding row, causing damage to emerging seedlings. This risk can be reduced by increasing the spread of seed and fertiliser in the row, reducing in-furrow fertiliser rates or separating seed and fertiliser bands.*

(SOURCE: GRDC)

18 Scott, B, Martin, P, Riethmuller, G (2013) Row spacing of winter crops in broad scale agriculture in southern Australia, Graham Centre Monograph No. 3, NSW Department of Primary Industries, Orange, www.grahamcentre.net

The bulk of fertilisers used in WA can damage germinating seeds if applied in close proximity and in a concentrated band.

Use of wider row spacing and no-tillage seeding systems can result in more fertiliser being placed in the seeding row, causing damage to emerging seedlings. This risk can be reduced by increasing the spread of seed and fertiliser in the row, reducing in-furrow fertiliser rates or separating seed and fertiliser bands.[19]

If row spacing is increased but the fertiliser rate per hectare remains constant, the amount of fertiliser in each row increases. The narrow seed spread typically created by disc seeders can also increase the potential for seedling damage by fertiliser.

Urea is most likely to cause damage, unless twin shoot boots are used. Diammonium phosphate (DAP) is also a potential problem when using wide row spacing on light soils.[20]

Fertilisers are essentially salts and can affect the ability of the crop seedling to absorb water by osmosis. Too much fertiliser (salt) near the seed can cause desiccation or 'burning'.

However, fertilisers vary in salt index — or burn potential — depending on composition. Most common N and K fertilisers typically have a higher salt index than P fertilisers.

Fertilisers that have the potential to release free ammonia can cause ammonia toxicity in seed and, because of this, in-furrow placement of fertilisers containing ammonium phosphate and urea is not typically advised.

A solution of urea and ammonium nitrate can be applied successfully in-furrow, but there is a risk of ammonia damage where high rates are used — especially when germinating seedlings are stressed.

Soil conditions that tend to concentrate salts or stress the germinating seed increase the potential for damage. Therefore, the safe limit for in-furrow fertilising is reduced in lighter soil texture (sands) and in drier soil conditions. It is also reduced when environmental conditions, such as cool temperatures, induce stress or slow germination — as this can prolong fertiliser-to-seed contact and increase the likelihood of damage.

Good rain immediately after sowing can reduce the potential for damage, as salts are diluted and ammonia is dissolved. This reduces the concentrations around the seed.

The toxic effects on germination can be avoided by banding fertilisers away from the seed or by topdressing.

2.8 Managing crown rot

Durum wheat remains the most susceptible of the winter cereal crops to crown rot (caused by the fungus *Fusarium pseudograminearum*).

Management strategies such as rotations, use of fallow, stubble management, inter-row sowing and planting time have been researched and benefits demonstrated.[21]

However, there is limited data about the effect of varying target plant population on the carry-over effect on soil water available for the critical crop development stages of flowering and grain fill — which dictates the extent of yield loss to crown rot.

The biggest impact on durum wheat yield from this disease is inoculum level.

Crown rot has more effect on wheat yield in environments that tend to have hotter and drier conditions during grain fill.[22]

Analysis of soil water and plant pathology data should provide additional insights into the impact of crown rot on soil water use.

19 GRDC (2011) Fact Sheet 'Crop placement and row spacing', GRDC, www.grdc.com.au/GRDC-FS-CropPlacementWest

20 GRDC (2011) Fact Sheet 'Crop placement and row spacing', GRDC, www.grdc.com.au/GRDC-FS-CropPlacementWest

21 R Hare (2006) Agronomy of the Durum Wheats Kamilaroi, Yallaroi, Wollaroi and EGA Bellaroi, Primefacts 140, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/63646/Agronomy-of-the-durum-wheats---Primefact-140-final.pdf

22 Serafin, L and Simpfendorfer, S (2010) Impact of Plant Population on Crown Rot in Durum Wheat, NSWDPI, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/IMPACT-OF-PLANT-POPULATION-ON-CROWN-ROT-IN-DURUM-WHEAT

However, under high crown rot pressure, yield losses in durum wheat cannot typically be managed by manipulating the target plant population at sowing.[23]

Given the extreme susceptibility of durum wheat to crown rot, it remains critical to target durum production only in paddocks that are known to have low levels of inoculum. See Section 5 for more detail.

2.9 Pre and post-emergent herbicides

When selecting a herbicide for any weed control, it is important to know the weeds present, crop growth stage, recommended growth stage for herbicide application and herbicide history of the paddock.

Research has found durum wheat varieties differ in tolerance to herbicides registered for use in durum wheat crops (see Section 6 for more detail).[24]

2.10 Canopy management

Canopy management refers to the practice of manipulating the green surface area of the crop canopy to optimise crop yield and inputs.

It is based on the premise that the crop's canopy size and duration determine its photosynthetic capacity and, therefore, its overall grain productivity.[25]

In eastern States grain growing regions, adopting canopy management principles and avoiding excessively vegetative crops enables durum wheat growers to ensure a better match of canopy size with yield potential as defined by the water available. WA bread wheat growers use similar strategies.

There are a range of management tactics to manipulate crop growth and development, including the rate and timing of applied fertiliser N. Some of these are outlined below:

- Select a target head density for the environment
- Adjust canopy management based on paddock nutrition, history and seeding time to achieve target head density
- Establish plant populations of 80–200 plants/m^2 (depending on location)
- Lower plant densities (80–100 plants/m^2) may suit earlier sowings/high fertility and/or low yield potential/low-rainfall environments
- Higher plant densities (150–200 plants/m^2) may suit later sowings, lower fertility situations and/or higher rainfall regions
- During stem elongation (GS30–39 on the Zadoks Growth Scale) provide the crop with necessary nutrition and fungicides to:
    - » Maximise potential grain size and grain number per head
    - » Maximise transpiration efficiency
    - » Ensure complete radiation interception from when the flag leaf has emerged (GS39)
    - » Keep the canopy green for as long as possible following anthesis.[26]

The main difference between canopy management and N topdressing is that all – or part – of the N input is tactically delayed until later in the growing season.

This tends to reduce early crop canopy size, but the canopy is maintained for longer – measured by green leaf retention – during the grain fill period.

23 Serafin, L and Simpfendorfer, S (2010) Impact of Plant Population on Crown Rot in Durum Wheat, NSWDPI, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/IMPACT-OF-PLANT-POPULATION-ON-CROWN-ROT-IN-DURUM-WHEAT

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

25 Poole, N (2005) Cereal Growth Stages, GRDC, https://grdc.com.au/resources-and-publications/all-publications/bookshop/2010/11/disease-management-and-crop-canopies

26 GRDC (2014), Advancing the Management of Crop Canopies, GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2014/01/gc105-canopymanagement

The timing of the applied N during the GS30-33 window can be adjusted to take into account target head numbers, earlier applications during this window (around GS30) and where tiller numbers and soil N seem deficient for the desired head number.

Conversely, where tiller numbers are high and crops are still regarded as too thick, N can be delayed further until the second or third node (GS32–33), which can result in less tillers surviving to produce a head.[27]

In a lower moisture profile situation, N can be applied at a rate that is less than the target yield/level requirement and topped-up before rainfall – as opportunities present. This requires careful planning and preparation to take advantage of impending rainfall, sometimes in a short time-frame.[28]

The 50–50 split application of N extends the period that N can be applied through the season without a 'cliff face' drop in yield if the N is not applied at precisely GS30–31. In practice, this improves the margin of error available to the grower if rainfall does not occur at GS30–31.

More information about nutrition and fertiliser is provided in Section 4.

27 GRDC (2014), Advancing the Management of Crop Canopies, GRDC, https://grdc.com.au/news-and-media/news-and-media-releases/north/2014/05/guide-details-canopy-management-principles

28 McMullen, G (2009) Canopy management in the northern grains region — the research view, Consultants Corner, Australian Grain, July 2009, http://www.nga.org.au/results-and-publications/download/31/australian-grainarticles/general-1/canopy-management-tactical-nitrogen-in-winter-cereals-july-2009-.pdf