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GRDC
GROWNOTES™

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

WHEAT

SECTION 2

PRE-PLANTING

VARIETAL PERFORMANCE AND RATINGS | PLANTING SEED QUALITY

SECTION 2

Pre-planting

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Evaluation of alternative dual purpose cereals for grazing and grain production 2010

Flowering time of wheat varieties in New South Wales

Comparing profitability of wheat growing in different productivity districts in SA and the implications for management decision making

Wheat varieties - A flour miller's perspective

Yield and protein relationships in wheat

New wheat cultivars for the high rainfall zone

Pushing the production barriers – what does it take to grow 10 t/ha of wheat and 4 t/ha of canola?

2.1 Varietal performance and ratings

For best results, use varieties yielding consistently well over several years that offer the best combination of yield potential, grain quality and disease resistance. Sow at least two different wheat varieties each year; this spreads the risk of frost and disease damage.

To ensure high yields, select varieties by considering:

- varieties that have performed well at a local level
- grain quality to attract premium payments, such as Australian Prime Hard (APH) in northern New South Wales (NSW)
- good disease-resistance package
- maturity suited to sowing time
- strong seedling vigour
- resistance to lodging and shattering
- tolerance to herbicides
- tolerance to soil acidity or sodicity
- tolerance to pre-harvest sprouting
- ability to perform well in low or marginal moisture conditions
- good threshing ability
- tolerance to frost [1]

Figure 1: Sow at least two varieties each year to spread the risk of frost and disease damage. (Nitrogen trials in the Liverpool Plains. Photo: Rachel Bowman)

[1] P Matthews, D McCaffery, L Jenkins (2014) Winter crop variety sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

2.1.1 Yielding ability and GRDC-funded National Variety Trials

Grains industry productivity depends on the continued adoption and deployment of new technologies, including the adoption of new varieties with superior yield and useful disease-resistance characteristics. When considering a new variety, growers should compare the yield, grain quality and disease resistances of the new variety with the currently grown varieties.

National Variety Trials (NVT) collect the most relevant varieties for each region, both new and old, and test them alongside the elite lines from the breeding programs. For all the information on the released varieties in the National Variety Trials, visit the website (www.nvtonline.com.au). [2]

Individual trial results from NVT provide only a snapshot in time and may lead to unsuitable varietal choice. Combining data across trials (and years) enhances the chance of selecting appropriate varieties, and the current long-term analysis is based on geographic region. A new method of analysis forms environment groups from 'similar' trials rather than geographic regions and will provide the most accurate prediction of relative yield performance of varieties for an environment. [3]

For more information on Yield Prophet®, see Section 1: Planning/paddock preparation.

More information

A number of GRDC apps have been developed to aid decision-making. To find out more, visit: www.grdc.com.au/resources/apps

2.1.2 Maturity

The maturity, or length of time taken for a variety to reach flowering, depends on vernalisation, photoperiod and thermal time requirements. Recommended sowing times are arrived at by assessing the maturity of varieties in different environments and with different sowing times. Figure 2 shows the variation in development stages when a variety is sown on different dates. [4] Some varieties have a wide planting window and they are not adversely affected by a later sowing date, e.g. EGA Gregory(D). [5]

More information

http://www.nvtonline.com.au/wp-content/uploads/2014/01/NSW-DPI-Primefact-914-Yield-response-of-wheat-varieties-to-sowing-time-2013.pdf

http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/What-is-driving-flowering-time-differences-of-wheat-varieties-between-years

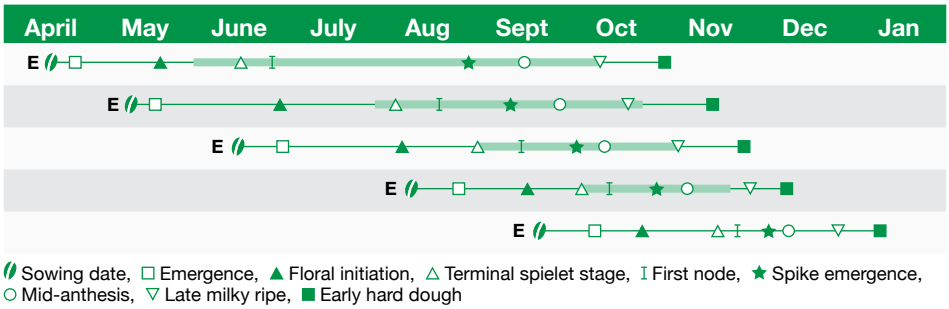

Figure 2: Development stages for varieties sown on different dates.
Source: Based on M Stapper & R Fischer,1990a.

[2] National Variety Trials (2013) Queensland 2013 wheat varieties. GRDC/Department of Agriculture, Fisheries and Forestry Queensland, http://www.grdc.com.au/NVT-QLD-WheatVarietyGuide

[3] A Kelly (2013) Which variety should I grow? New statistical methods for NVT allow for better decision making. GRDC Update Papers 12 March 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Kelly-Alison-What-should-I-grow

[4] NSW DPI Agronomists (2007) Wheat growth and development. PROCROP Series, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

[5] NSW DPI Agronomists (2007) Wheat growth and development. PROCROP Series, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

Figure 3 shows the yield response of a range of wheat varieties to sowing time (year day of sowing). [6] The solid line in each panel is the estimated grain yield. The dashed lines are upper and lower 95% confidence limits.

It is critical to match variety and sowing date so that flowering occurs early enough to allow a long grain filling period before the high evaporative demands and soil water deficit of early summer. The flowering period must also be late enough to avoid damage by frosts in early spring.

Because the timing of the autumn break can range from April until June, farmers in NSW have the choice of a range varieties with differing maturities. Understanding how each variety responds to the environment will help target varieties to their best sowing time.[7]

There are large differences in flowering time between years. EGA Gregory was 15 days shorter from sowing to anthesis in 2013 compared to 2012 at sites in southern NSW.

Varieties generally flower in the same order across years and sowing times.

For more information, see There are large differences in flowering time between years. EGA Gregory was 15 days shorter from sowing to anthesis in 2013 compared to 2012 at Wagga

Varieties generally flower in the same order across years and sowing times.

For more information, see http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/What-is-driving-flowering-time-differences-of-wheat-varieties-between-years[8]

6 P Martin, P Matthews (2014) NSW DPI Yield response of wheat varieties to sowing time 2013. Fourth edn. NSW Department of Primary Industries Primefact 914, Jan. 2014, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/280115/Yield-response-of-wheat-varieties-to-sowing-time-2013.pdf

7 GRDC (2014), Flowering time of wheat varieties in New South Wales. http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Flowering-time-of-wheat-varieties-in-New-South-Wales

8 GRDC (2014), What is driving flowering time differences of wheat varieties between years. http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/What-is-driving-flowering-time-differences-of-wheat-varieties-between-years

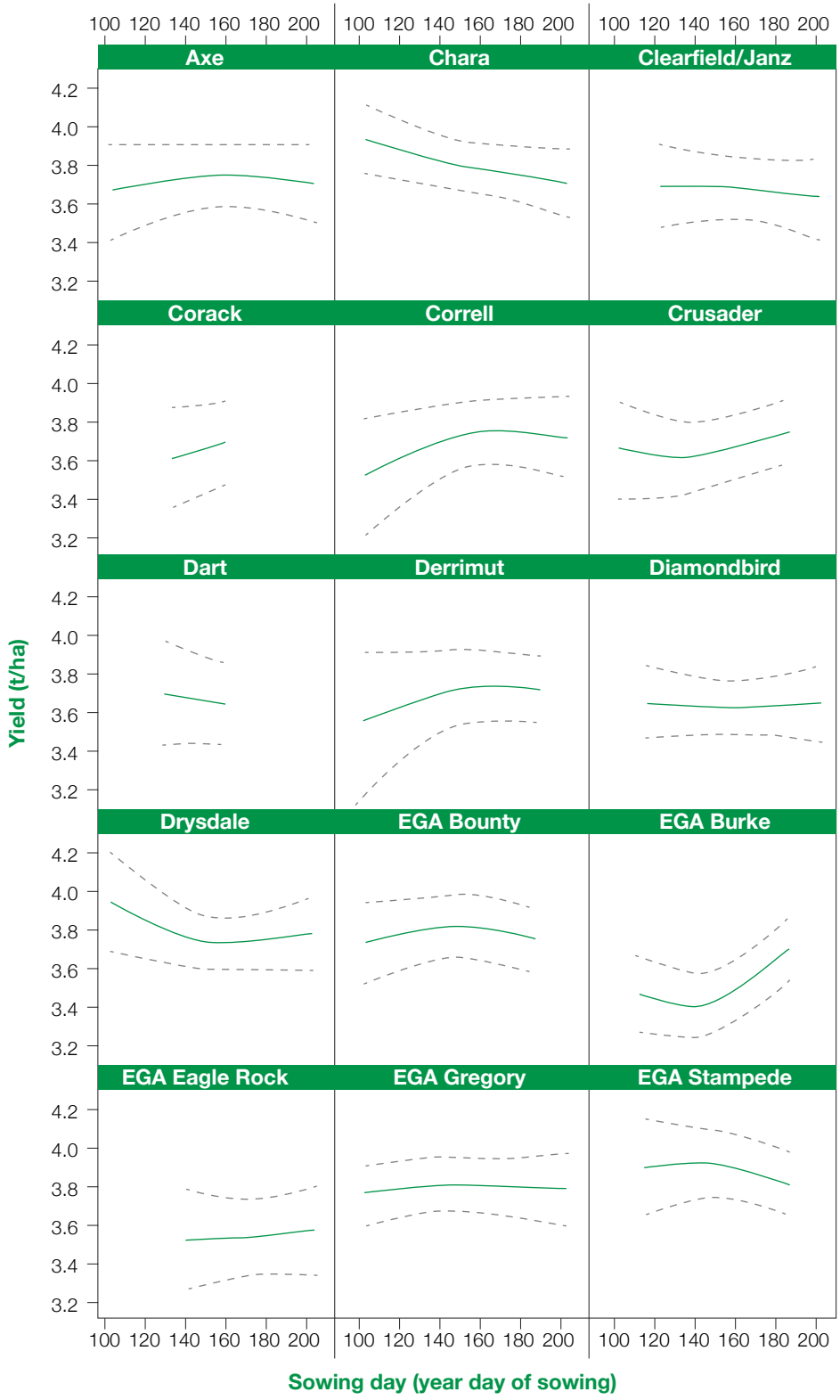

Figure 3: Yield response (t/ha) curves for common varieties. Solid lines are estimated grain yield; dashed lines are upper and lower 95% confidence limits.

The maturity of varieties available in NSW varies greatly; consequently, there is a range of optimum sowing times. Up-to-date tables are published each year in the winter crop variety sowing guides.

More information

http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

Sowing of a variety outside the sowing window increases the risk of flowering occurring at the wrong time, leading to frost damage or high temperatures at flowering and grain-fill. Trials in northern NSW showed reductions in relative grain yield of 5–7% for each week that sowing was delayed after the end of June. For research results on flowering times (Figure 4). [9]

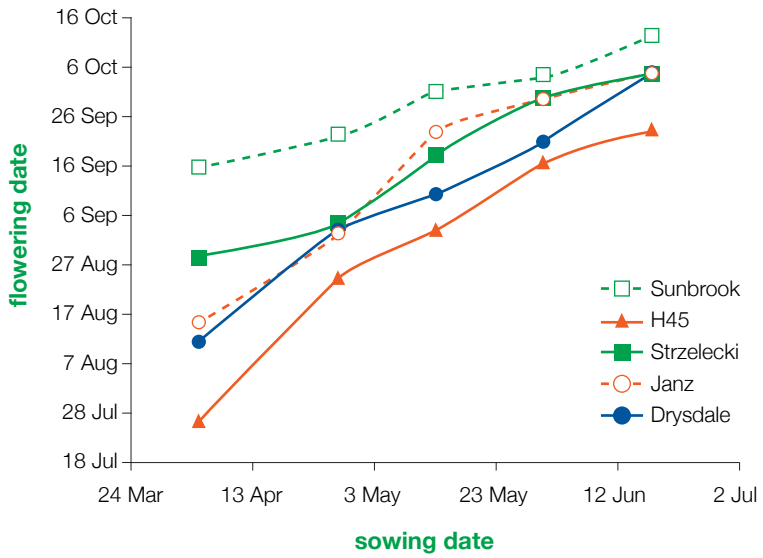

Figure 4: Flowering dates for five wheat varieties sown on five dates at Condobolin.

In sowing-time trials conducted throughout NSW, the response of four varieties to different sowing times was measured. The results showed variations in yield stability for different varieties over a range of sowing times.

For more information on the influence of sowing time, see *Section 3: Planting*.

2.1.3 Protein and other quality traits

There has been considerable discussion among growers and agronomists as to whether some varieties achieve higher grain protein than others when grown under the same conditions during recent seasons.

It is generally considered that there are only minor differences among commercial varieties for grain protein accumulation. However, growers and agronomists have suggested that, relative to other varieties, EGA Gregory(Þ) has lower grain protein concentration. Note, though, that Gregory(Þ) has demonstrated wide adaptation across grain-growing regions in NSW, with high relative yields, good resistance to stripe rust, high level of tolerance to root-lesion nematode (RLN; *Pratylenchus thornei*), flexibility with sowing date, and classification as an Australian Hard (AH) or APH variety depending on the region. [10]

Higher yields than the other varieties may be the reason for the low protein, i.e. the amount of nitrogen (N) leaving the paddock is the same, and in most years, the gross margin from high yield will surpass that from achievement of higher protein-grade wheat. For example, Spitfire(Þ) is perceived to have higher protein content but lower yield than EGA
Gregory(Þ). Spitfire(Þ) is more efficient at obtaining N from the soil than other cultivars.

More information

GRDC Fact Sheet:
http://www.grdc.com.au/uploads/documents/GRDC_FS_TimeOfSowing_North.pdf

More information

GRDC Update Papers:
http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/02/Grain-protein-How-important-is-variety-choice

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Low-protein-is-it-timing-decision-making-or-something-else

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Will-low-protein-become-the-new-norm

[9] GRDC, http://www.grdc.com.au/~/media/EE56800EFE0D42E2AA14987603DA4BE4.pdf

[10] N Fettell, R Brill, M Gardner, G McMullen (2012) Grain protein—How important is variety choice? GRDC Update Papers 28 Feb. 2012, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/02/Grain-protein-How-important-is-variety-choice

More information

Australian Agronomy Conference Paper: http://www.regional.org.au/au/asa/2012/breeding/8188_brillr.htm

Nsw DPI Northern Grains Region Trial Results 2012: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/430291/Northern-grains-region-trial-results-autumn-2012.pdf (see p. 39 of 'Does N management need to differ between commercial wheat varieties?')

More information

GRDC Update Papers: http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Low-protein-is-it-timing-decision-making-or-something-else

http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/02/Grain-protein-How-important-is-variety-choice

It averages 1% higher protein content than other varieties, but this protein expression appears to be greater under high N conditions. [11]

Analysis of NVT data and 2011 trial results confirmed the negative correlation between grain yield and grain protein concentration, although the slope of the relationship varied greatly among sites (Figure 5). For the biggest data set, the NSW NVT trials, grain protein decreased by 0.6 percentage units for each 1 t/ha of yield increase for the three varieties. [12]

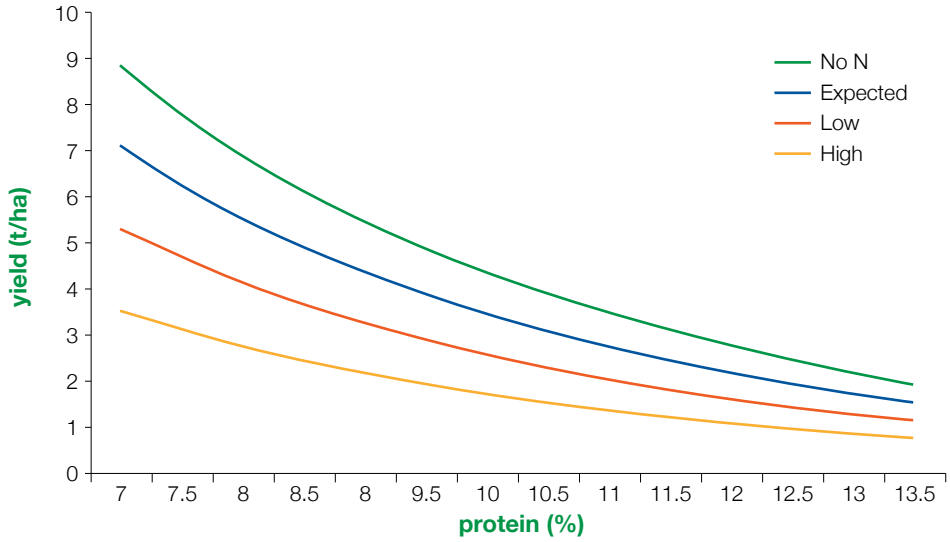

Figure 5: A range of grain yield and protein outcomes based on a range of soil and fertiliser nitrogen (N) availability and standard N-transfer efficiencies associated with grain protein percentage. Total crop N supply (kg N/ha): 60 (no N added), 90 (low), 120 (expected) and 150 (high). [13]

As yield and protein are inversely proportional, if the rate of N is increased, yield will generally increase to a maximum level, whereas protein may continue to increase with further N application. This is demonstrated by the results from a trial at Parkes in 2011, sown as part of the Variety Specific Agronomy Packages (VSAP) project (Figure 6). Yield was maximised with N application of 90 kg/ha. Protein increased linearly for each 30 kg/ha increment up to 120 kg N/ha. In this trial, yield appeared to be maximised at a grain protein concentration of 11.2%. [14]

11 R Brill, M Gardner, R Graham, N Fettell (2013) Will low protein become the new norm? GRDC Update Papers 25 Feb. 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Will-low-protein-become-the-new-norm

12 N Fettell, R Brill, M Gardner, G McMullen (2012) Grain protein—How important is variety choice? GRDC Update Papers 28 Feb. 2012, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/02/Grain-protein-How-important-is-variety-choice

13 C Dowling (2013) Low protein: is it timing decision making or something else? GRDC Update Papers 5 March 2013, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Low-protein-is-it-timing-decision-making-or-something-else

14 N Fettell, R Brill, M Gardner, G McMullen (2012) Grain protein—How important is variety choice? GRDC Update Papers 28 Feb. 2012, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/02/Grain-protein-How-important-is-variety-choice

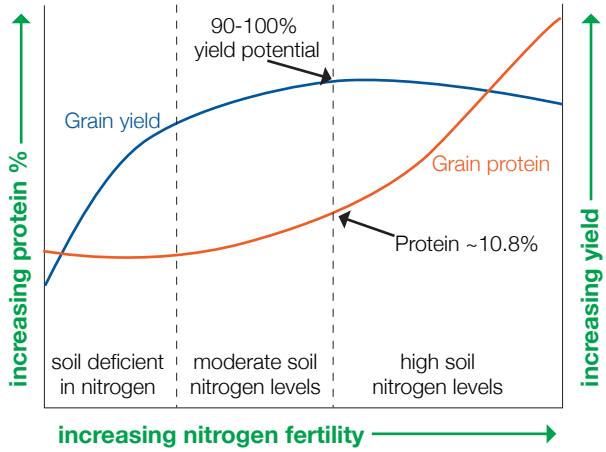

Figure 6: Representation of the relationship between yield and grain protein with increasing nitrogen fertility.

The relative importance of yield and protein will depend on grain prices and particularly the spread between grades. The situation is further complicated by the re-emergence of 'cliff-face' pricing and by price volatility at harvest time.

Recent trials have focused on genotypic response, and genotype was shown to play a relatively minor role in determining grain protein compared with N nutrition and environmental conditions during grain filling. Future work within the VSAP project will investigate whether N rates or timing should vary for different varieties, especially with regard to varieties such as Gregory(Þ and Spitfire(Þ. [15]

More information

Winter crop variety sowing guide 2015.

NVT Queensland Wheat Variety Guide 2015.

2.1.4 Varieties

Axe(Þ Australian Premium White classification in NSW. Very early maturity, similar to slightly earlier than H45. Moderately susceptible to stem rust and resistant–moderately resistant to stripe rust. Susceptible to leaf rust, yellow leaf spot and cereal cyst nematode. Axe is not boron tolerant. Susceptible to black point. Produces very large grain with low screenings. AGT.

Barham(Þ Awnless. Biscuit wheat. Australian soft quality in southern NSW. Improved rust resistance, grain yield and quality over Bowie. Mid season maturity, similar to Bowie. Moderately resistant–moderately susceptible to stem and leaf rust. Susceptible to stripe rust and Septoria tritici blotch. Moderately susceptible–susceptible to yellow leaf spot. Moderately resistant to root lesion nematode (*P. neglectus*). Moderately susceptible to cereal cyst nematode and black point. Seednet.

Baxter(Þ Australian Prime Hard quality. Combines high tolerance to root lesion nematode (*P. thornei*) and moderate susceptibity to crown rot. Maturity similar to Cunningham. Moderately susceptible– susceptible to stripe rust, susceptible to yellow leaf spot. High protein achiever. Heritage Seeds.

Bolac(Þ Australian Prime Hard quality in southern NSW and Australian Premium White northern NSW. Later maturing than Chara. Adapted to mildy acidic, neutral and alkaline soils. Moderately resistant–moderately susceptible to stem rust, resistant–moderately resistant to stripe rust and susceptible to leaf rust. Susceptible to yellow leaf spot. Small grain size. Seednet.

Bowie. Awnless. Biscuit wheat. Australian Soft quality. Moderately resistant–moderately susceptible to cereal cyst nematode. Susceptible to stripe and stem rust. Moderately susceptible to Septoria tritici blotch.

[15] N Fettell, R Brill, M Gardner, G McMullen (2012) Grain protein—How important is variety choice? GRDC Update Papers 28 Feb. 2012, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/02/Grain-protein-How-important-is-variety-choice

Corack(ɒ) Australian Premium White quality in NSW. An early maturing Wyalkatchem derivative that has yielded well in low and medium rainfall environments and/or tight finishes to the growing season. It has high straw strength, good resistance to cereal cyst nematode and yellow leaf spot. May be suitable for a wheat on wheat situation, low rainfall environments or late sowings. Corack is rated moderately resistant to stem rust, moderately susceptible to stripe and susceptible–very susceptible to leaf rust. Susceptible to powdery mildew to moderately susceptible–susceptible black point. Corack has a high level of tolerance to acid soils. AGT.

Correll(ɒ) Australian Hard quality in southern NSW. A Yitpi derivative with improved stem rust resistance, black point tolerance and Septoria tritici blotch resistance. Mid season, similar maturity and adaptation to Yitpi with high levels of boron tolerance. Produces lower test weights than Yitpi. AGT.

Derrimut(ɒ) Australian Premium White quality. Medium to early maturity, medium to short in height. Moderately susceptible to leaf rust, moderately resistant to stem rust, moderately susceptible–susceptible to stripe rust. Susceptible to yellow leaf spot, Septoria tritici blotch and black point. Cereal cyst nematode resistant. Area of adaptation southern NSW. Nuseed.

EGA_Bounty(ɒ) Australian Hard quality. Suitable for early to mid season sowings. Moderately resistant to stem and stripe rust, moderately susceptible to leaf rust. Moderately susceptible to yellow leaf spot. Susceptible to crown rot and common root rot. Moderately tolerant to root lesion nematode (*P. thornei*). Moderately susceptible–susceptible to black point. Nuseed.

EGA_Burke(ɒ) Australian Prime Hard quality in northern NSW and Australian Hard in southern NSW. Suitable for early to mid season sowings. Medium to medium–slow maturity, similar to Giles. Moderately resistant to stem rust, moderately resistant–moderately susceptible to leaf rust and moderately susceptible to stripe rust. Susceptible to crown rot, moderately susceptible–susceptible to common root rot and yellow leaf spot. Moderately tolerant and moderately susceptible to root lesion nematode (*P. thornei*). Resistant– moderately resistant to black point. Pacific Seeds.

EGA_Eaglehawk(ɒ) Australian Prime Hard quality in southern NSW and Australian Hard in northern NSW. Late maturing spring type, similar to Sunbrook. Resistant–moderately resistant to stem rust and moderately resistant–moderately susceptible to stripe rust. Moderately susceptible to Septoria tritici blotch and flag smut. Tolerant to acid soils. Moderately tolerant to root lesion nematode (*P. thornei*). Heritage Seeds.

EGA_Gregory(ɒ) Australian Prime Hard quality in northern NSW and Australian Hard in southern NSW. Similar maturity, straw strength and height to Batavia and Strzelecki. Moderately resistant to leaf, stem and stripe rust. Good tolerance to root lesion nematode (*P. thornei*). Susceptible to yellow leaf spot and crown rot and moderately resistant–moderately susceptible to common root rot. Pacific Seeds.

EGA_Wedgetail(ɒ) Winter wheat– see note page 32. Australian Prime Hard quality in southern NSW and Australian Hard quality in northern NSW. Acid soils-tolerant, early sowing variety. Large grain size. Similar maturity and height to Rosella. Adapted to higher rainfall regions in southern and central NSW and the eastern part of the northern wheat belt. Moderately resistant–moderately susceptible to stem rust and moderately susceptible to stripe and leaf rust. Moderately susceptible–susceptible to Septoria tritici blotch, crown rot and yellow leaf spot. Seednet.

EGA_Wills(ɒ) Australian Hard quality in northern NSW and Australian Premium White classification for southern NSW. Early to mid season variety. Resistant–moderately resistant to stem rust and moderately resistant–moderately susceptible to stripe rust and common root rot. Susceptible to crown rot, moderately susceptible to yellow leaf spot. Moderately tolerant to root lesion nematode (*P. thornei)*. Moderately susceptible to black point. Good resistance to shattering, good straw strength. Pacific Seeds.

EGA_Wylie(ɒ) Australian Hard quality. Suited to northern NSW. A sister line to Baxter with improved disease and lodging resistance. Medium maturity, slightly longer maturity

than Baxter. Resistant to stem rust, moderately susceptible to leaf and stripe rust. Tolerant–moderately tolerant to root lesion nematode (*P. thornei*). Moderately resistant–moderately susceptible to crown rot, moderately susceptible to common root rot. Moderately susceptible–susceptible to yellow leaf spot. Good black point resistance. Pacific Seeds.

Ellison(ϕ) Australian Prime Hard quality. Mid season maturity. Moderately resistant to stem rust and moderately susceptible to stripe rust. Moderately resistant–moderately susceptible to yellow leaf spot. Susceptible–very susceptible to crown rot and moderately susceptible– susceptible to root lesion nematode (*P. thornei)*. Moderately resistant to sprouting. AGT.

Elmore CL PLUS(ϕ) Australian Hard quality classification in NSW. A mid-maturing variety with Clearfield® Plus technology, which provides tolerance to label rates of Intervix® herbicide. The line has an adaptation pattern similar to Janz and is expected to perform well in moderate to high yield potential areas in NSW, providing an alternative strategy for in-crop weed control. Elmore CL PLUS is rated as moderately resistant–moderately susceptible to stripe rust, resistant–moderately resistant to leaf rust and moderately resistant to stem rust. Susceptible to yellow leaf spot and cereal cyst nematode. AGT.

Emu Rock(ϕ) Australian Hard quality classification for southern NSW. Early season variety with broad adaptation. Produces large grain with good test weight and has a low susceptibility to screenings. Moderately resistant–moderately susceptible to yellow leaf spot, stripe and stem rust, and susceptible to leaf rust. Susceptible to cereal cyst nematode. Bred by InterGrain and marketed by Nuseed.

Espada(ϕ) Australian Hard quality in southern NSW. Mid season variety with wide adaptation. Good seedling vigour. Produces large grain with low screenings. Moderately resistant–moderately susceptible to stripe rust. Susceptible to Septoria tritici blotch. Moderately susceptible to cereal cyst nematode and susceptible to root lesion nematode (*P. neglectus*). Tolerant of boron. AGT.

Estoc(ϕ) Australian Standard White quality in southern NSW. Mid to late season variety, 1–3 days earlier than Yitpi. Cereal cyst nematode resistance and boron tolerance. Moderately resistant to stem rust, moderately resistant–moderately susceptible to leaf rust and moderately susceptible to stripe rust. AGT.

Forrest(ϕ) Australian Premium White quality southern NSW and Australian Standard White quality in northern NSW. Forrest is a long season spring wheat best suited to mid to high rainfall areas of southern NSW. Forrest is rated as moderately susceptible–susceptible to leaf rust, resistant–moderately resistant to stem and stripe rust, moderately resistant–moderately susceptible to yellow leaf spot and is currently the only releasedwheat variety with tolerance to Wheat streak mosaic virus. Moderately resistant to black point. Released by Advantage Wheats and marketed by Seednet.

Giles(ϕ) Australian Prime Hard quality in northern NSW and Australian Hard quality in southern NSW. Strong straw. Similar maturity to Sunvale. Moderately susceptible to stripe rust, moderately intolerant to root lesion nematode (*P. thornei*). Moderately susceptible– susceptible to yellow leaf spot and common root rot and susceptible to crown rot. Heritage Seeds.

Gladius(ϕ) Australian Hard quality in southern NSW and Australian Premium White in northern NSW. Mid–quick season maturity, similar to Diamondbird and Drysdale. Maintains high relative grain yields under drought stress. Moderately resistant–moderately susceptible to stripe rust, moderately resistant to stem rust, moderately susceptible to leaf rust and yellow leaf spot, moderately susceptible– susceptible to Septoria tritici blotch. Boron tolerant. Moderately susceptible to cereal cyst nematode and root lesion nematode (*P. neglectus*). AGT.

Grenade CL PLUS(ϕ) Australian Premium White quality in NSW. An early to mid maturing line, carrying Clearfield Plus® technology which provides tolerance to label rates of Intervix herbicide. Grenade CL PLUS combines the flexibility of improved weed management options through the use of Intervix® with high yield and cereal cyst

nematode resistance. Grenade CL PLUS is rated moderately resistant–moderately susceptible to stripe rust, susceptible to leaf rust and moderately resistant to stem rust. Susceptible to yellow leaf spot. AGT.

Janz◊ Australian Prime Hard quality. Widely adapted main season variety. Moderate seedling vigour. Medium to strong straw with good lodging and shattering resistance. Good milling quality. Susceptible to yellow leaf spot and crown rot, moderately susceptible to stripe rust, moderately resistant–moderately susceptible to leaf rust.

Justica CL PLUS◊ Australian Premium White classification in southern NSW. A mid maturing variety, possessing Clearfield® Plus technology which provides tolerance to label rates of Intervix® herbicide. Justica CL PLUS is most suited to the mid to high yielding environments of southern NSW. Rated susceptible to leaf rust, moderately resistant to stem rust, moderately resistant–moderately susceptible to stripe rust, susceptible to yellow leaf spot and moderately susceptible to cereal cyst nematode. AGT.

Kord CL PLUS◊ Australian Premium White classification in southern NSW. An early to mid maturing variety with CCN resistance and Clearfield® Plus technology which provides tolerance to label rates of Intervix® herbicide. Kord CL Plus performance has been better at sites and in years that have experienced terminal drought stress. Rated moderately susceptible to leaf rust, moderately resistant to stem rust, moderately resistant–moderately susceptible to stripe rust, moderately susceptible–susceptible to yellow leaf spot and moderately resistant to CCN. AGT.

Livingston◊ Australian Hard quality. Early maturing variety, later than H45 but earlier than Ventura and Sunstate. Moderately resistant–moderately susceptible to stripe and stem rust. Moderately susceptible to leaf rust and yellow leaf spot, and susceptible to crown rot. Moderately tolerant to root leasion nematode (*P. thornei*), moderately resistant–moderately susceptible to black point. Intolerant of acid soils. AGT.

LongReach Cobra◊ Australian Hard quality in southern NSW. High yielding early-mid season variety suited to both acid soils and alkaline soil types. Compact plant height, moderately resistant to lodging and has performed particularly well on irrigation and in high production areas. Resistant– moderately resistant to stem rust, moderately susceptible–susceptible to stripe rust and moderately resistant to leaf rust. Moderately susceptible to cereal cyst nematodes and moderately resistant–moderately susceptible to yellow leaf spot. Pacific Seeds.

LongReach Crusader◊ Australian Prime Hard quality. Quick maturity, similar to Ventura and H45. Strong straw with good lodging resistance. Moderately resistant–moderately susceptible to leaf rust, resistant– moderately resistant to stem rust, moderately susceptible to stripe rust. Susceptible to crown rot. Moderately susceptible to yellow leaf spot. Pacific Seeds.

LongReach Dart◊ Australian Prime Hard quality in NSW. Quick maturity suited to later plantings, slightly quicker than Ventura, LongReach Crusader and H45. Suited to Queensland, NSW and NE Victoria. Late plantings may be a useful tool in herbicide resistance management. Good physical grain, milling and baking quality. Moderately resistant to stripe rust, (resistance to stripe rust based on adult plant resistance (APR)) and stem rust. Susceptible–very susceptible to leaf rust. Rated moderately susceptible to yellow leaf spot. Lower tillering variety, with a long coleoptile and good early seedling vigour. Pacific Seeds.

LongReach Gauntlet◊ Australian Prime Hard in northern NSW and Australian Hard quality in southern NSW. Main season maturity, similar to Janz and Lang. Fully awned. Medium length coleoptile with good early seedling vigour, short–medium plant height at maturity. Resistant–moderately resistant to stem rust, moderately resistant–moderately susceptible to stripe rust and moderately susceptible to leaf rust. Moderately susceptible to yellow leaf spot and moderately susceptible–susceptible to crown rot. Moderately resistant to root lesion nematode (*P. thornei*). Performs well in acid soils. Seednet.

LongReach Gazelle◊ Biscuit wheat. Australian Soft quality in NSW. Mid to late season maturity, similar to QAL2000 and slightly quicker than Yenda. Fully awned. Medium length coleoptile with good early seedling vigour, medium plant height at maturity and suited to high rainfall production areas and irrigation. Moderately resistant to stem rust, stripe rust and leaf rust. Very susceptible to powdery mildew. Good soft wheat grain package with low screenings, low protein accumulation and good test weight. Pacific Seeds.

LongReach Impala◊ Biscuit wheat. Australian Soft quality in NSW. Quick to main season maturity, similar to Lincoln and Ventura. Fully awned. Medium length coleoptile with good early seedling vigour, medium plant height at maturity. Moderately resistant to stem and stripe rust, and susceptible–very susceptible to leaf rust. Good soft wheat grain package with low screenings, low protein accumulation and good test weight. Pacific Seeds.

LongReach Lancer◊ Australian Prime Hard milling quality in NSW. Slower maturing spring wheat for earlier planting opportunities. Medium coleoptile length and has a medium plant height at maturity, improved lodging resistance over EGA_Gregory. Stripe rust resistance based on adult plant resistance, rated moderately resistant, resistant to stem rust and resistant–moderately resistant to leaf rust. Moderately susceptible to yellow leaf spot. Tolerant–moderately tolerant to root lesion nematode (*P. thornei*). Moderately susceptible–susceptible to crown rot. Pacific Seeds.

LongReach Lincoln◊ Australian Hard quality. Medium maturity, slightly earlier than Janz. Erect, strong and upright canopy. Well suited to southern NSW. Moderately resistant to stem rust and resistant–moderately resistant to stripe rust. Moderately susceptible–susceptible to yellow leaf spot and moderately resistant–moderately susceptible to black point. Very susceptible to crown rot and pre-harvest sprouting. Pacific Seeds.

LongReach Merlin◊ Australian Hard milling wheat, with early to mid season maturity similar to Ventura, Baxter and Drysdale. Suited to NSW and NE Vic. A Drysdale type with similar growth habit. A sister line to LongReach Spitfire, with a similar grain quality package. Stripe rust resistance package based on adult plant resistance (APR), rated moderately resistant. Moderately susceptible to crown rot and moderately tolerant–moderately intolerant to root lesion nematode (*P. thornei*). Pacific Seeds.

LongReach Orion◊ Awnless. Biscuit wheat. Australian Soft quality. Mid season maturity, similar to Bowie and QALBis. Long coleoptile with good seedling vigour. Resistant to leaf rust and moderately resistant to stem rust, moderately susceptible–susceptible to stripe rust and yellow leaf spot. Performs well in acid soils. Pacific Seeds.

LongReach Phantom◊ Australian Premium White in NSW. A mid to late season variety with similar area of adaptation as Yipti. Tolerance to boron and acid soils. Sprouting tolerance similar to Yitpi with good black point tolerance. Moderately susceptible for stem rust, moderately susceptible–susceptible leaf rust, moderately resistant for stripe rust. Moderately resistant–moderately susceptible to cereal cyst nematode but susceptible– very susceptible to yellow leaf spot. Pacific Seeds.

LongReach Scout◊ Australian Premium White in southern NSW. Mid season maturity, similar to Gladius. Rated as resistant to cereal cyst nematode. Good grain package with low screenings and high test weight. Moderately resistant to stem rust moderately resistant–moderately susceptible to leaf rust and moderately susceptible to stripe rust. Very susceptible–susceptible to yellow leaf spot. Medium to long coleoptile with good early vigour. Performs well in both alkaline and acid soils. Pacific Seeds.

LongReach Spitfire◊ Australian Prime Hard quality in NSW. Early to mid season maturity, similar to Ventura and Livingston. Good soil disease control against crown rot and root lesion nematode (*P. thornei*). Good grain package with low screenings and high test weights. Moderately resistant to stem and stripe rust, susceptible to leaf rust. Moderately susceptible–susceptible for yellow leaf spot. Long coleoptile and medium plant height. Performs well in acid soils. Pacific Seeds.

LongReach Trojan(þ) Australian Premium White in southern NSW. Mid to long season maturity suited to the medium-high rain zone of southern Australia. Short to medium plant height at maturity. Moderately tolerant to boron. Moderately resistant–moderately susceptible to stem and leaf rust, and moderately resistant to stripe rust. Useful levels of resistance to cereal cyst nematodes, rated moderately susceptible. Pacific Seeds.

Mace(þ) Australian Hard quality in NSW. Has good tolerance to stem rust, however is susceptible–very susceptible to stripe rust and should only be grown where a full fungicide management program can be implemented. Has shown good adaptation in South Australia and Victoria wheat producing regions. AGT.

Merinda(þ) Australian Hard quality. Mid season maturity, similar to Janz. Resistant–moderately resistant to stem rust and resistant to leaf rust. Moderately resistant–moderately susceptible to stripe rust. Susceptible–very susceptible to crown rot and moderately susceptible–susceptible to yellow leaf spot. Moderately tolerant to root lesion nematode (*P. thornei*). Moderately resistant to black point. AGT.

Peake(þ) Australian Hard quality for southern NSW and Australian Premium White in northern NSW. Area of adaptation southern NSW. Medium to early maturity, medium to short in height. Moderately susceptible–susceptible to leaf rust, moderately resistant to stem rust and moderately susceptible to stripe rust. Cereal cyst nematode resistance. Nuseed.

Petrel. Awnless. For hay/white chaff production. Aim to sow late May to early June, but adjust so the crop can be cut for hay in optimum weather. Can be grazed if sown early.

QALBis(þ) Biscuit wheat. Australian Soft quality for NSW. Similar maturity to Sunstate. Resistant– moderately resistant to stem rust and susceptible– very susceptible to stripe rust and susceptible to crown rot. Austgrains International.

QAL2000(þ) Biscuit wheat. Australian Soft quality. Similar maturity to Sunstate. Resistant–moderately resistant to stem rust and resistant to leaf rust, very susceptible to stripe rust. Susceptible–very susceptible to crown rot. Austgrains International.

Rosella. Winter wheat. Australian Standard White/Noodle quality. Widely adapted with good seedling vigour. A useful dual-purpose grazing wheat. Strong straw but with early sowing and higher soil fertility it may lodge when not grazed. Mid season maturity once cold requirement is met.

Sentinel3R(þ) Australian Standard White quality in NSW. Later maturing than Janz. Resistant– moderately resistant to stem and stripe rust. Resistant to leaf rust. Moderately susceptible–susceptible to crown rot. Moderately susceptible to yellow leaf spot. Moderately susceptible–susceptible to black point, susceptible to pre-harvest sprouting and resistant to shattering. Short coleoptile. Seednet.

Shield(þ) Australian Premium White quality in southern NSW. An early to mid-maturing, high quality line with good disease resistance and competitive grain yield. Shield has achieved grain yield levels a little lower than Wyalkatchem across southern Australia. Resistant–moderately resistant to stripe rust and moderately resistant–moderately susceptible to cereal cyst nematodes and moderately susceptible–susceptible to yellow leaf spot. AGT.

Strzelecki(þ) Australian Prime Hard quality for northern NSW and Australian Hard quality in southern NSW. Resistant to leaf rust, moderately resistant–moderately susceptible to stem rust, moderately resistant to stripe rust. Moderately susceptible to yellow leaf spot. Susceptible to crown rot, moderately resistant to common root rot. Susceptible–very susceptible and intolerant to root lesion nematode (*P. thornei*). Heritage Seeds.

Sunbri. Australian Prime Hard quality. Resistant to stem rust and moderately resistant to stripe rust. Moderately susceptible to yellow leaf spot and crown rot. Does not have the seedling vigour of many other varieties. Avoid sowing deeper than 10 cm.

Sunbrook(þ) Australian Prime Hard quality for northern NSW and Australian Hard quality in southern NSW. A long season spring wheat, not suited to very early sowing. Good seedling vigour. Strong straw. Prone to shattering. AGT.

Sunco. Australian Prime Hard quality. Moderate straw strength. Moderately susceptible to crown rot. In crown rot-free paddocks, lower yielding than other varieties with similar maturity. Resistant to stem rust, moderately resistant to leaf rust, moderately resistant–moderately susceptible to stripe rust.

Sunguard(ϕ) Australian Hard quality classification in NSW. Sunguard is moderately tolerant to root lesion nematode (*P. thornei*), and exhibits a similar level of crown rot tolerance to EGA_Wylie with higher yield potential. A main season Janz derivative, is rated resistant to stem rust, moderately resistant to stripe rust and leaf rust and moderately susceptible–susceptible to yellow leaf spot. AGT.

Sunlin. Awnless. Australian Prime Hard quality. Excellent sprouting tolerance and grain retention in the head at harvest. Moderately resistant to stripe rust and moderately resistant–moderately susceptible to stem rust. Moderately susceptible–susceptible to crown rot. Resistant–moderately resistant to common root rot, moderately susceptible to yellow leaf spot and moderately resistant–moderately susceptible to Septoria tritici blotch. Susceptible to root lesion nematode (*P. thornei*). Susceptible to black point. Some frost tolerance. AGT.

Suntop(ϕ) Australian Prime Hard quality in NSW. A main season line that is well adapted to NSW, showing high and stable yields from low to high yield potential areas. Suntop is quicker maturing than EGA_Gregory, similar in maturity to Janz. Moderately resistant to stem rust and moderately resistant–moderately susceptible to stripe and leaf rust. It has moderate tolerance to acid soils and root lesion nematode (*P. thornei*). It is also moderately resistant to root lesion nematode (*P. thornei*). Suntop is rated moderately susceptible–susceptible to yellow leaf spot and moderately susceptible–susceptible to crown rot. AGT.

Sunvale(ϕ) Australian Prime Hard quality. Main season maturity. Medium straw strength. Resistant to stem rust, susceptible to leaf rust and moderately resistant to stripe rust. Moderately susceptible–susceptible to crown rot. Moderately susceptible to common root rot. AGT.

Sunvex(ϕ) Australian Prime Hard quality for northern NSW and Australian Hard in southern NSW. A Sunvale derivative. Mid to late maturing line with similar maturity to Sunvale. Resistant to stem rust, moderately resistant to stripe and leaf rust. Moderately resistant–moderately susceptible to yellow leaf spot, susceptible to crown rot. Moderately susceptible to black point. AGT.

Sunzell(ϕ) Australian Prime Hard quality for southern NSW and Australian Hard in northern NSW. Acid soils tolerant early sowing variety. Slightly longer season than Strzelecki. Moderately resistant–moderately susceptible to leaf rust, moderately susceptible to stripe rust, moderately resistant to stem rust. Moderately susceptible–susceptible to yellow leaf spot. Moderately susceptible–susceptible to crown rot. Moderately tolerant to root lesion nematode (*P. thornei*). AGT.

Ventura(ϕ) Australian Hard quality. Main season semidwarf spring wheat. Sunstate maturity. Good straw strength. Resistant–moderately resistant to stem rust, and moderately susceptible–susceptible to leaf and stripe rust. Moderately resistant–moderately susceptible to root lesion nematode (P. thornei). Moderately susceptible–susceptible to crown rot. Susceptible to yellow leaf spot and moderately susceptible–susceptible to Septoria tritici blotch. Tolerant of black point and acid soils. AGT.

Waagan(ϕ) Australian Standard White quality for southern NSW. A widely adapted, very early maturing spring wheat, similar to H45. High yield potential in medium to low rainfall environments. Moderately intolerant of acid soils. Susceptible to stripe rust, moderately susceptible to leaf rust and black point, and moderately susceptible–susceptible stem rust. Susceptible to Septoria tritici blotch. AGT.

Wallup(ϕ) Australian Prime Hard quality classification in NSW. A wheat which has very good grain processing quality characteristics and high straw strength. Moderate coleoptile length. Best suited to medium yield potential environments, but has not performed as well in Mallee environments. It is intolerant of toxic levels of soil boron

and acid soils. Moderately resistant to cereal cyst nematode, moderately resistant–moderately susceptible to stem and stripe rust, and susceptible–very susceptible to leaf rust. Moderately susceptible–susceptible to yellow leaf spot. Intermediate level of resistance to pre-harvest sprouting and black point and expresses low levels of screenings. AGT.

Yenda(ϕ) Biscuit wheat. Australian Soft quality in southern NSW. Short stiff strawed variety suitable for irrigation and high rainfall areas. Resistant to stem rust and susceptible to stripe rust. Moderately resistant–moderately susceptible to yellow leaf spot, moderately susceptible to Septoria tritici blotch and cereal cyst nematode. Seednet.

The following are more recently released varieties with limited data available.

Condo(ϕ) Australian Hard quality in NSW. Tested as VX1634. Early maturity, adapted to low to medium rainfall areas of NSW. Similar in maturity to Livingston. Condo has a tall plant type with medium straw strength. Resistant–moderately resistant to stem rust, moderately resistant–moderately susceptible to leaf rust and moderately susceptible–susceptible to stripe rust. Moderately susceptible–susceptible to yellow leaf spot and tolerant–moderately tolerant of root lesion nematode (*P. thornei*). Moderately susceptible–susceptible to crown rot. Moderately tolerant of acid soils. Released in 2014. AGT.

Kiora(ϕ) Australian Hard quality in southern NSW and Australian Prime Hard in northern NSW. Tested as VX2485. Medium to late maturity suited to early to mid season sowings in medium to high rainfall areas. A possible replacement for Bolac in medium to high rainfall environments. Resistant–moderately resistant to stem and stripe rust. Moderately resistant–moderately susceptible to leaf rust. Moderately susceptible–susceptible to yellow leaf spot and moderately tolerant to root lesion nematode (*P. thornei*). Susceptible to crown rot and black point. Released in 2014. AGT.

LongReach Viking(ϕ) Australian Prime Hard quality in NSW. Tested as LPB08-0079. Mid-late maturity, similar to EGA_Gregory that suits early May plantings. Viking has a similar plant type and early growth habit to Chara, but is taller, being comparable in height to EGA_Gregory at maturity. Moderately resistant to stem rust and susceptible–very susceptible to leaf rust. Resistant–moderately resistant to stripe rust. Moderately susceptible–susceptible to yellow leaf spot and crown rot. Tolerance to root lesion nematode (*P. thornei*). Susceptible to Septoria tritici blotch. Release in 2014. Pacific Seeds.

Mitch(ϕ) Australian Hard quality in northern NSW and Australian Premium White in southern NSW. Tested as QT14381. Mid to late maturing variety, suited to late April early May sowing in northern NSW. Similar height to EGA_Gregory, but has improved straw strength. It is moderately resistant–moderately susceptible to stem and stripe rust. Susceptible–very susceptible to leaf rust . Moderately susceptible to yellow leaf spot, moderately tolerant–moderately intolerant to root lesion nematodes (*P. thornei*) and moderately susceptible to crown rot. It is moderately resistant to black point. Released in 2014. AGT.

Sunmate(ϕ) Australian Prime Hard quality in northern NSW and Australian Hard quality in southern NSW. Tested as SUN595I. An early maturing variety similar to Spitfire. Moderately resistant–moderately susceptible to stem and stripe rust, and moderately susceptible to leaf rust. Moderately susceptible–susceptible to yellow leaf spot and tolerant–moderately tolerant and moderately resistant to root lesion nematode (*P. thornei*). Moderately susceptible–susceptible to crown rot. Moderately tolerant–moderately intolerant of acid soils. Released in 2014. AGT.[16]

[16] P Matthew, D McCaffery, L Jenkins (2014) Winter crop variety sowing guid 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0011/272945/winter-crop-variety-sowing-guide-2015.pdf

More information

GRDC Update Papers:
http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Agronomic-tweaks-for-new-and-not-so-new-wheat-varieties

To select varieties, visit www.nvtonline.com.au or download the current wheat variety guides produced by NSW Department of Primary Industries (DPI) and GRDC/ Department of Agriculture Fisheries and Forestry Queensland (DAFF):
http://www.grdc.com.au/NVT-QLD-WheatVarietyGuide
http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

2.2 Planting seed quality

2.2.1 Seed size

Early seedling growth relies on stored energy reserves in the seed. Good seedling establishment is more likely if seed is undamaged, stored correctly and from a plant that had adequate nutrition. Seed should not be kept from paddocks that were rain-affected at harvest. Seed grading is an effective way to separate good quality seed of uniform size from small or damaged seeds and other impurities, such as weed seeds.

Seed size is also important—the larger the seed, the greater the endosperm and starch reserves. While size does not alter germination, bigger seeds have faster seedling growth, a higher number of fertile tillers per plant and potentially higher grain yield.

Seed size is usually measured by weighing 1000 grains, known as the 1000-grain weight. Sowing rate needs to vary according to the 1000-grain weight for each variety, in each season, in order to achieve desired plant densities. [17]

To measure 1000-grain weights, count out 10 lots of 100 seeds, then weigh. When purchasing seed, remember to request the seed analysis certificate, which includes germination percentage, and the seed weight of each batch where available.

The coleoptile is the pointed, protective sheath that encases the emerging shoot as it grows from the seed to the soil surface (see Figure 7). Coleoptile length is an important characteristic to consider when planting a wheat crop, especially in drier seasons when sowing deep to reach soil moisture. The NSW DPI Fact Sheet *'Coleoptile length of wheat varieties'* shows the results of 2008 research at three sites.

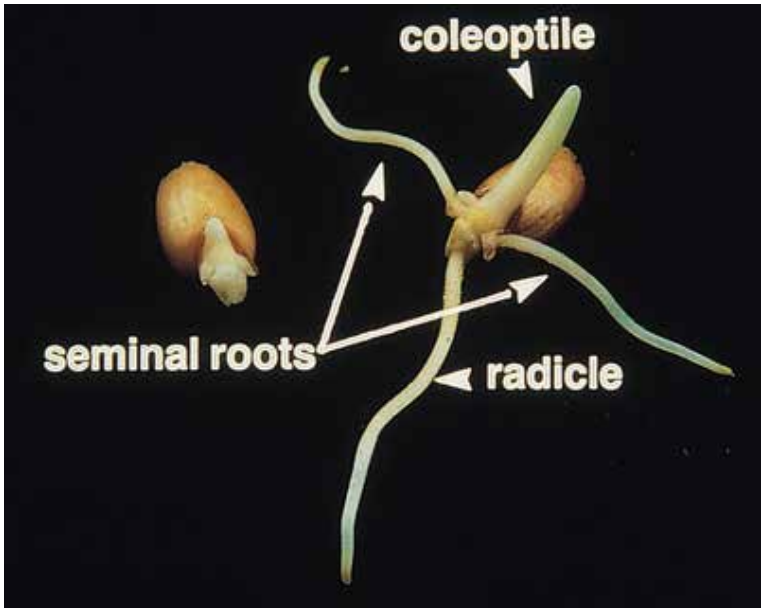

Figure 7: The coleoptile is the pointed, protective sheath that encases the emerging shoot as it grows from the seed to the soil surface. (Photo: University of Minnesota. David L. Hansen)

[17] NSW DPI Agronomists (2007) Wheat growth and development. PROCROP Series, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

More information

http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/459006/Coleoptile-length-of-wheat-varieties.pdf

For wheat seed to emerge successfully from the soil, the seed should never be planted deeper than the coleoptile length. Sowing varieties with short coleoptile lengths too deep can cause poor establishment, as the shoot will emerge from the coleoptile underground and it may never reach the soil surface.

Coleoptile length is influenced by several factors including variety, seed size, temperature, low soil water and certain seed dressings, such as those with the active ingredient triadimenol or flutriafol. Trifluralin and several Group B pre-emergent chemicals can also affect coleoptile length. Growers should read the label when using any seed-dressing fungicide for wheat to see what effect it may have on coleoptile length. [18]

2.2.2 Seed germination and vigour

Seed germination and vigour greatly influence establishment and yield potential.

Germination begins when the seed absorbs water, and ends with the appearance of the radicle. It has three phases:

- water absorption (imbibition)
- activation
- visible germination [19]

Seed vigour affects the level of activity and performance of the seed or seed lot during germination and seedling emergence. Loss of seed vigour is related to a reduction in the ability of the seeds to carry out all of the physiological functions that allow them to perform.

This process, called physiological ageing (or deterioration), starts before harvest and continues during harvest, processing and storage. It progressively reduces performance capabilities due to changes in cell membrane integrity, enzyme activity and protein synthesis. These biochemical changes can occur very quickly (a few days) or more slowly (years), depending on genetic, production and environmental factors not yet fully understood. The end point of this deterioration is death of the seed (i.e. complete loss of germination).

However, seeds lose vigour before they lose the ability to germinate. That is why seed lots that have similar, high germination values can differ in their physiological age (the extent of deterioration) and so differ in seed vigour and therefore the ability to perform. [20]

For more information on factors affecting germination, see *Section 4: Plant growth and physiology*.

Request a copy of the germination and vigour analysis certificate from your supplier for purchased seed. For seed stored on-farm, you can send a sample to a laboratory for analysis (http://aseeds.net.au/seed-testing).

While a laboratory seed test for germination should be carried out before seeding to calculate seeding rates, a simple on-farm test can be done in soil at harvest and during storage:

- Use a flat, shallow, seeding tray (about 5 cm deep). Place a sheet of newspaper on the base to cover drainage holes, and fill with clean sand, potting mix or freely draining soil. Ideally, the test should be done indoors at a temperature of ~20°C or lower.

[18] J Pumpa, P Martin, F McCrae, N Coombes (2013) Coleoptile length of wheat varieties. NSW Department of Primary Industries, Feb. 2013, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/459006/Coleoptile-length-of-wheat-varieties.pdf

[19] NSW DPI Agronomists (2007) Wheat growth and development. PROCROP Series, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

[20] ISTA (1995) Understanding seed vigour. International Seed Testing Association, http://www.seedtest.org/upload/prj/product/UnderstandingSeedVigourPamphlet.pdf

- Alternatively, lay a well-rinsed plastic milk container on its side and cut a window in it, place unbleached paper towels or cotton wool in the container, and lay out the seeds. Moisten and place on a window-sill. Keep moist, and count the seeds as outlined below.
- Randomly count out 100 seeds, do not discard damaged ones, and sow 10 rows of 10 seeds at the correct seeding depth. This can be achieved by placing the seed on the smoothed soil surface and pushing in with a pencil marked to the required depth. Cover with a little more sand/soil and water gently.
- Keep soil moist but not wet, as overwatering will result in fungal growth and possible rotting.
- After 7–10 days, the majority of viable seeds will have emerged.
- Count only normal, healthy seedlings. If you count 78 normal vigorous seedlings, the germination percentage is 78%.
- Germination of 80% is considered acceptable for cereals.
- The results from a laboratory seed-germination test should be used for calculating seeding rates. [21]

Disease

Grain retained for seed from a wet harvest is more likely to be infected with seed-borne disease. It is also more likely to suffer physical damage during handling, increasing the potential for disease.

Seed-borne disease generally cannot be identified from visual inspection, so requires laboratory testing. Once a satisfactory germination percentage is known, seed should be tested for diseases such as Fusarium head blight (FHB). [22]

Several commercial wheat crops in northern NSW in 2011 experienced high levels of crown rot, even though they followed good rotations such as canola and double-cropped chickpeas after sorghum. Seed-borne infection with *Fusarium* was suspected, and it was possible to trace it back, in some cases, by culturing grain that growers had retained from their 2011 plantings.

It was found that the seed had high levels of *Fusarium* from FHB that had occurred during wet conditions around flowering and grain-fill in 2010. FHB relates to the symptoms of head infection causing premature ripening of infected spikelets, caused by two fungi, *F. graminearum* or *F. pseudograminearum*, following wet weather during flowering and/or grain-fill. The problem with grain infection with *Fusarium*, a result of FHB in wet seasons, is that if grain is sown the next year it can cause seedling death, which reduces emergence, and a crown rot infection can be introduced to the base of surviving plants through the *Fusarium*-infected seed.

Grain infection with *Fusarium* only occurs from FHB, which is favoured by wet conditions during flowering. Crown rot alone cannot directly result in grain infection, as the fungus does not grow up the entire stem and into heads within a season.

Additional trial work by the NSW DPI at Tamworth in 2011, which was part-funded by the GRDC, investigated the effect of grain infection with *Fusarium* on emergence and causing crown rot infection in surviving plants (seed-borne crown rot infection). [23]

More information

GRDC Ground Cover Article: http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-98-May-June-2012/Seedborne-Fusarium-tests-crown-rot-strategies

[21] GRDC (2011) Retaining seed. Saving weather damaged grain for seed, northern and southern regions. GRDC Fact Sheet Jan. 2011, http://storedgrain.com.au/wp-content/uploads/2013/06/GRDC_FS_RetainingSeed2.pdf

[22] GRDC (2011) Retaining seed. Saving weather damaged grain for seed, northern and southern regions. GRDC Fact Sheet Jan. 2011, http://storedgrain.com.au/wp-content/uploads/2013/06/GRDC_FS_RetainingSeed2.pdf

[23] S Simpfendorfer (2012) Seed-borne *Fusarium* tests crown rot strategies. GRDC Update Papers 27 April 2012, http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-98-May-June-2012/Seedborne-Fusarium-tests-crown-rot-strategies

More information

http://aseeds.net.au/seed-testing

http://www.graintrade.org.au/sites/default/files/file/Commodity%20Standards/2013_2014/Section%2002%20-%20Wheat%20Standards%20201314(1).pdf

2.2.3 Seed purity

Seed impurity can occur from contamination through harvest, storage and machinery. This measurement will be included in a seed purity certificate. Varieties that have been retained for multiple generations have an increased risk of seed impurity due to multiple chances for contamination events and build-up. Ensuring that seed comes from clean, pure and even crops is imperative, and seed purity tests should be carried out. Growers should conduct paddock audits prior to harvest to establish which paddocks best meet these criteria.

With the dramatic increase in herbicide resistance in the region, growers need to take seed purity into account when deciding on paddock selection for seed wheat. Ryegrass and black oats frequently appear in harvested grain samples and have the potential to infest otherwise clean paddocks.

Sunvale case study

Research shows that impurity (variety contamination) is quite common in commercial Sunvale(Þ) crops. Pure Sunvale(Þ) remains moderately resistant to stripe rust and does not require in-crop fungicide management. However, if the Sunvale(Þ) seed has been contaminated with a stripe-rust-susceptible variety, as evident in 16 of the commercial seed lots, then stripe rust may be prevalent and warrant chemical control. A simple variety mix-up (e.g. Sunvale 15(Þ)) also appears to be an issue, as well as variety misidentification, which meant that the crop did not have APR to stripe rust.

Researchers were not surprised that high levels of impurity were observed in commercial Sunvale(Þ) lots, given that it is a 17-year-old variety. Growers need to take care in ensuring variety purity and correct identification of seed lots for planting. This study also emphasises the value in growers conducting careful observation of head type and the pattern of disease distribution in crops that are showing unexpected disease reactions.

This is the first report of seed impurity being determined as the cause of unexpected stripe rust responses within a wheat variety. This situation is unlikely to be unique to Sunvale(Þ) and may explain mixed reports of stripe rust levels commercially in more recently released, moderately resistant varieties such as EGA Gregory(Þ). [24]

The GRDC has invested in the development of a new commercial, cost-effective DNA test to identify the variety and purity of wheat and barley samples.

More information

GRDC Ground Cover Article: http://www.grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-105-July-August-2013/New-quality-assurance-for-wheat-and-barley

2.2.4 Seed storage

The aim of storage is to preserve the viability of the seed for future sowing and maintain its quality for market. A seed is a living organism that releases moisture as it respires. The ideal storage conditions are listed below.

- Temperature <15°C. High temperatures can quickly reduce seed germination and quality. This is why germination and vigour testing prior to planting is so important in the northern region.
- Moisture control. Temperature changes cause air movements inside the silo, carrying moisture to the coolest parts of the seed. Moisture is carried upwards by convection currents in the air; these are created by the temperature difference between the warm seed in the centre of the silo and the cool silo walls, or *vice versa*. Moisture carried into the silo head space may condense and fall back as free water, causing a ring of seed to germinate against the silo wall.
- Aeration slows the rate of deterioration of seed with 12.5–14% moisture. Aeration markedly reduces grain temperature and evens out temperature differences that cause moisture movement.

[24] S Simpfendorfer, A Martin, M Sutherland (2012 Seed impurity undermines stripe rust resistance. 16th Australian Agronomy Conference. Australian Society of Agronomy/the Regional Institute Ltd, http://www.regional.org.au/au/asa/2012/disease/8325_simpfendorfer.htm#TopOfPage

- No pests. Temperature <15°C stops all major grain insect pests from breeding, slowing down their activity and causing less damage. [25]

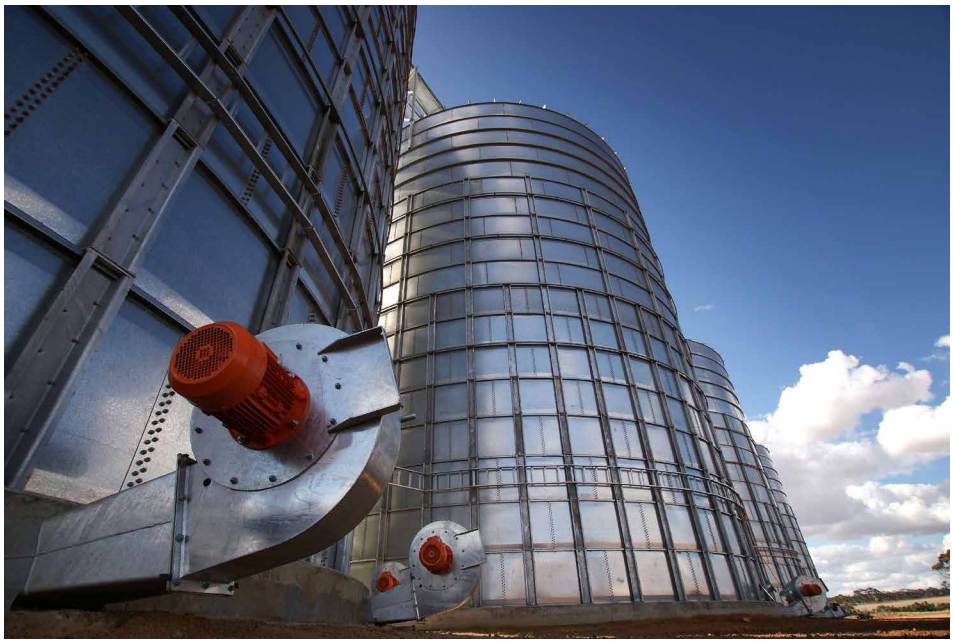

Figure 8: Aeration markedly reduces grain temperature. (Photo: Kondinin Group)

2.2.5 Safe rates of fertiliser sown with the seed

Crop species differ in tolerance to N fertiliser when applied with the seed at sowing. Recent research work funded by Incitec Pivot Fertilisers has shown that the tolerance of crop species to ammonium fertilisers placed with the seed at sowing is related to the fertiliser product (ammonia potential and osmotic potential), the application rate, row spacing and equipment used (such as a disc or tine), and soil characteristics such as moisture content and texture. [26]

The safest application method for high rates of high ammonium content fertilisers is to place them away from the seed by physical separation (combined N–phosphorus products) or by pre- or post-plant application (straight N products). For the lower ammonium content fertilisers, e.g. mono-ammonium phosphate (MAP), close adherence to the safe rate limits set for the crop species and the soil type is advised. [27]

High rates of N fertiliser applied at planting in contact with, or close to, the seed may severely reduce seedling emergence. If a high rate of N is required, then it should be applied pre-planting or applied at planting but not in contact with the seed (i.e. banded between and below sowing rows). Rates should be reduced by 50% for very sandy soil and increased by 30% for heavy-textured soils or if soil moisture conditions at planting are excellent. [28] See Tables 1 and 2 for more detail.

Nitrogen rates should be significantly reduced when using narrow points and press wheels or disc seeders. When moisture conditions are marginal for germination, growers need to reduce N rates if fertiliser is to be placed with, or close to, the seed.

More information

GRDC Fact Sheet: http://www.grdc.com.au/uploads/documents/GRDC_FertiliserToxicity_FS.pdf

25 NSW DPI Agronomists (2007) Wheat growth and development. PROCROP Series, NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

26 BigN (2014) Nitrogen fertiliser placement and crop establishment. Incitec Pivot Ltd, http://bign.com.au/Big%20N%20Benefits/Nitrogen%20Fertiliser%20Placement%20and%20Crop%20Establishment

27 BigN (2014) Nitrogen fertiliser placement and crop establishment. Incitec Pivot Ltd, http://bign.com.au/Big%20N%20Benefits/Nitrogen%20Fertiliser%20Placement%20and%20Crop%20Establishment

28 BigN (2014) Nitrogen fertiliser placement and crop establishment. Incitec Pivot Ltd, http://bign.com.au/Big%20N%20Benefits/Nitrogen%20Fertiliser%20Placement%20and%20Crop%20Establishment

Table 1: Approximate safe rates of nitrogen as urea, mono-ammonium phosphate (MAP) or di-ammonium phosphate (DAP) with the seed of cereal grains if the seedbed has good soil moisture (at or near field capacity)

	25mm (1") seed spread			50mm (2" seed spread)		
Soil texture	Row spacing			Row spacing		
	180mm (7")	229mm (9")	305mm (12")	180mm (7")	229mm (9")	305mm (12")
	SBU			SBU		
	14%	11%	8%	29%	22%	17%
Light (sandy loam)	20	15	11	40	30	22
Medium-heavy (loam to clay)	25	20	15	50	40	30

Table 2: Urea rates for wheat and barley on different soil types [29]

Crop:	Wheat, barley							
Product:	Urea (46% nitrogen)							
Soil moisture:	**Good**							
SBU (%)	5	10	15	20	25	30	40	50
	kg/ha							
Heavy soil	55	60	65	70	75	80	95	105
Medium soil	45	50	55	60	65	70	80	90
Light soil	25	30	35	40	45	50	60	65

SBU, Seed bed utilisation. SBU% = (width of seed row/row spacing) x 100. Contact your agronomist or fertiliser supplier for other details on other blends

For more information, see Section 3: Planting and Section 5: Nutrition and fertiliser.

[29] Farmer Community (2014) Guidelines for suggested maximum rates of fertiliser applied with the seed in winter crops. Fertiliser Facts. Incitec Pivot Ltd, http://farmercommunity.incitecpivotfertilisers.com.au/