Department of Primary Industries
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NSW research results

RESEARCH & DEVELOPMENT – INDEPENDENT RESEARCH FOR INDUSTRY

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Dual-purpose cereal evaluation, Tamworth 2020

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Summary of results

- The cereals evaluated in this experiment had a high grain yield potential (i.e.>6 t/ha), after simulated grazing at stem elongation (GS30).
- Some varieties produced >5.0 t/ha dry matter (DM) at GS30.
- Yields varied in response to grazing and sowing date. Varieties, such as DS Bennett⁽ᵈ⁾ wheat, yielded ≥20% across all three sowing dates (e.g. SD3 4.82 t/ha non-grazed versus. 5.77 t/ha grazed).
- Other varieties, such as Cartwheel⁽ᵈ⁾ triticale, showed a decrease in grain yield with grazing. For SD2, Cartwheel⁽ᵈ⁾ had a 23% decrease from the non-grazed treatments compared to the grazed treatments (7.25 t/ha versus 5.56 t/ha respectively)
- The European feed quality wheats RGT Calabro, RGT Accroc and Einstein, achieved grain yields of between 6.90 t/ha and 6.01 t/ha for grazing treatments, for all three sowing dates (13 March, 2 April and 23 April). They produced between 5.21 t DM/ha –3.35 t DM/ha for potential winter grazing at GS30.
- Some higher quality, milling grade wheats performed well, providing high yielding, dual-purpose options for growers. Illabo⁽ᵈ⁾, an Australian Hard (AH) classified wheat, yielded 6.6 t/ha after being grazed (SD3). Likewise, EGA Wedgetail⁽ᵈ⁾ an AH and LongReach Kittyhawk⁽ᵈ⁾, (Prime Hard (APH)) were also high yielding (6.02 t/ha and 5.87 t/ha for SD3 and SD2 respectively). Biomass accumulation at GS30 [for which group of wheats?}, was significantly lower than the European wheats at between 2.37–2.14 t DM/ha, due to their faster rate of biomass accumulation and time to reach GS30.
- The two slow maturing spring wheats evaluated achieved grain yields of ≥6 t/ha following simulated grazing treatments, LongReach Nighthawk⁽ᵈ⁾ yielding 6.67 t/ha in SD3, and Sunlamb⁽ᵈ⁾ yielding 6.23 t/ha and 6.08 t/h from SD2 and SD3 respectively. Sunlamb⁽ᵈ⁾ produced the most biomass of the two varieties with ~3.0 t DM/ha at GS30 in SD2.
- The triticale Cartwheel⁽ᵈ⁾ yielded 6.35 t/ha from SD3 following grazing, which was comparable to the European wheats and produced good levels of biomass of ~3.8 t DM/ha at GS30. Cartwheel⁽ᵈ⁾ was also the second highest yielding variety yielding 7.68 t/ha in the SD3 non-grazed treatment. Cartwheel⁽ᵈ⁾ showed a yield penalty when grazed or where sowing was delayed.
- Barley was generally lower yielding than the better performing wheats and triticales. Dry matter production at anthesis (GS65), an indicator of potential hay production, ranged from 16.5 t DM/ha to 9.4 t DM/ha SD3. DM production at GS65 following grazing at GS30 tended to decline with later sowing times.

Introduction

Dual-purpose graze and grain cereals means that growers can exploit early sowing opportunities, potentially providing both valuable winter forage for livestock as well as income from grain. Excellent early season soil moisture profiles and planting opportunities in 2020, following on from severe droughts in 2018 and 2019, greatly increased the interest in early sowing options across the north-western slopes of NSW. Interest has been further heightened by the release and/or introduction of some newer high yielding winter and long spring wheat varieties, some with improved grain classifications, in addition to dual-purpose barley and triticale.

In 2020, 15 cereals varieties, (10 wheat, three barley and two triticale) were evaluated at Tamworth for their potential as dual-purpose graze and grain options. This research, a component of the NSW DPI-GRDC Grains Agronomy and Plant Pathology partnership (GAPP) project BLG116, is evaluating oat, wheat, barley, triticale, and canola for their potential for grain yield following 'simulated grazing'. Experiments were conducted at both Tamworth and Glen Innes in 2020.

Site details

Location	NSW DPI Tamworth Agricultural Institute (TAI), Tamworth, NSW (31° 15' 263" S; 150° 98' 525" E)
Soil type	Grey vertosol.
Paddock history	Sorghum 2018, long fallowed 2019
Starting soil nitrogen (N)	~300 kg N/ha (0–120 cm)
Starting soil phosphorus (P)	Colwell: 31 mg/kg (0–10 cm), 7 mg/kg (10–30 cm).
Starting water	~181 mm plant available water (PAW) to 120 cm.
Rainfall and temperature	Excellent starting soil water meant that the experiment was sown on the ideal dates, without the need for supplementary water. Rainfall and temperature data for the Tamworth site in 2020 is presented in Figure 1. Rainfall from 1 March to 30 November was 401 mm, which was slightly below the long-term median of 435 mm.

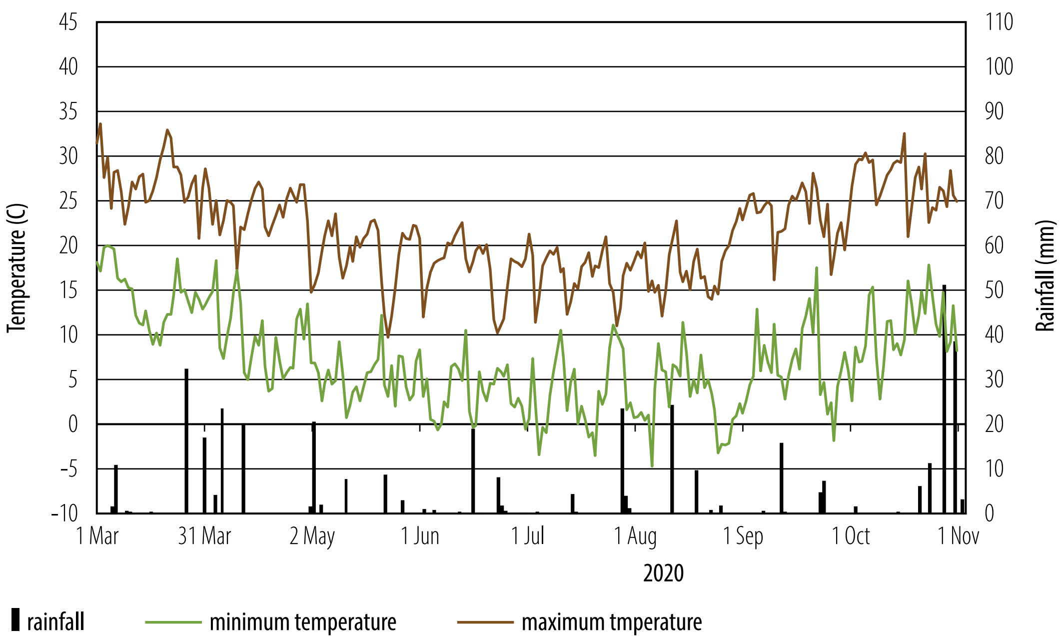

Figure 1 Rainfall and temperature data for Tamworth, 2020.

Fertiliser	• 60 kg/ha of starter fertiliser Granulock® Z applied at sowing 12% N, 21.8% P, 4% sulfur (S), 1.0% zinc (Zn). • 141 kg/ha urea (47% N) side banded at sowing.
Plant population	Target plant population: 100 plants/m^2.
Weed management	• 2 L/ha Glyphosate 450 (450 g/L glyphosate) and 1.2 L/ha LVE MCPA (570 g/L) applied as a pre-plant knockdown. • 900 mL/ha Starane® Advanced (333 g/L fluroxypyr), 500 ml/100L of water of Uptake® oil (582 g/l paraffinic oil, 240 g/L alkoxylated alcohol non-ionic surfactants) in-crop.
Disease management	• 200 mL/ha Jubilee® 500 (500 g/L flutriafol) applied in-furrow at sowing with fertiliser. • 285 mL/ha Propiconazole (250 g/L propiconazole) applied in-crop.
Harvest date	• SD1 and SD2: 18 November 2020. • SD3: 3 December 2020.

Experiment design

- Split plot design, three replicates.
- Treatments on main plot: three sowing dates.
- Treatments on split plot: 15 varieties combined with two grazing treatments (grazed and non-grazed).

Treatments

Sowing dates (3)

- SD1: 13 March
- SD2: 2 April
- SD3: 23 April.

Varieties (15)

- 15 varieties (10 wheat, three barley and two triticale).
- Evaluated for grain yield, grazing potential and grain yield recovery following grazing (Table 1).

Statistical analysis

Variation in the traits was described by fitting a linear mixed-effects model that considered sowing date, variety and grazing treatment plus all interactions as fixed effects. Random effects were assigned to replication, main plot, range, and row of the experiment. An analysis of variance was derived from the model to test the null hypothesis with respect to each fixed term. Graphical methods were used to check model assumptions of normal and homogeneous residuals.

The analysis of variance was used to infer a statistically important effect when the relevant F-ratio statistic exceeded the expected F-ratio under the null hypothesis at 5% critical value. Specific pairwise contrasts were made by comparing the estimated effect with a calculated least significant difference at 5% critical value. The models were also used to estimate the mean and standard error of the trait under all combinations of variety, grazing and sowing date. These were presented in figures 3, 4 and 5.

The estimates of grain yield, biomass and maturity are provided in more detail in Table 2. Grain quality data is presented in Table 3 and feed value analyses are presented in Table 4.

The data analysis was conducted in the R environment (R Core Team 2021) with particular use of the lme4 package (Bates et al. 2015).

Table 1 Description of varieties and seed source, Tamworth 2020.

Species/variety	Variety description
Wheat	
DS Bennett	A tall, awnless, white-grained feed quality, mid to slow winter wheat, which generally flowers 7–10 days later than EGA Wedgetail. It has a vigorous prostrate early growth habit and is suited to both grazing and grain production, or straight grain. Since the detection of the new stripe rust pathotype (198 E16 A+ J+ 17+ '198 pathotype') has lowered to a susceptible (S) rating for 2020. Bred in Australia.
EGA Wedgetail	Benchmark dual-purpose, AH quality, mid maturating awned winter wheat, released in 2002. Its popularity has been affected by changes in its stripe rust rating, which is moderately susceptible (MS). Lower grain quality compared with some newer varieties.
Einstein	A slow-maturing feed quality awnless red winter wheat. Better suited to higher rainfall zones, bred in the United Kingdom.
Illabo	A mid maturing awned winter wheat with a similar planting window and maturity (~2–3 days quicker) than EGA Wedgetail, released in 2018. It is classified as AH in the north and has improved stripe rust (moderately resistant [MR], previously resistant–moderately resistant [R–MR}) and black point resistance over EGA Wedgetail.
LongReach Kittyhawk	APH quality, mid maturing awned winter wheat with a similar maturity and planting window to EGA Wedgetail, released in 2016. Has improved stripe rust resistance (R–MR) and grain quality over EGA Wedgetail.
LongReach Nighthawk	A slow-maturing, awned spring wheat, with strong photoperiod sensitivity that allows it to be planted earlier in systems that don't suit traditional winter wheat types. Quality classification NNSW and QLD currently under review. Released in 2020.
Manning	A slow-maturing white grain feed quality awnless winter wheat, released in 2013. It has good standability and is resistant to *Barley yellow dwarf virus* (BYDV).
RGT Accroc	Slow-maturing, red feed quality awned winter wheat released in Australia in 2017. Suitable for sowing in late February to early April for early grazing. Good standability. Better suited to higher rainfall zones. Flowering time and maturity are later than EGA Wedgetail.
RGT Calabro	Slow-maturing, red feed quality awned winter wheat released in Australia in 2017. Suitable for sowing in late February to early April for early grazing, better suited to higher rainfall zones. Good standability.
Sunlamb	An awnless Australian Standard White (ASW) quality, long-season spring wheat suited to early April plantings, with strong photoperiod sensitivity, released in 2015. Suited to grazing and grain recovery across NSW.
Triticale	
Cartwheel	A long-season winter habit dual-purpose variety suitable for an early March to early April sowing. A stripe rust resistant replacement for Tobruk. Released in 2016.
Endeavour	A semi-awnless long-season winter habit dual-purpose benchmark variety. Excellent DM production and grain recovery after grazing. Suited to early sowing opportunities. Released in 2007.
Barley	
Cassiopee	French winter malt quality barley. Very long season (strong vernalisation and photoperiod responses). Bred by RAGT and released in Europe in 2012.
Oxford	A mid to late maturing spring type, with high yield potential and wide adaptation. Feed quality with good straw strength and lodging resistance. Resistant (R) to powdery mildew and moderately resistant (MR) to leaf rust. Bred in the United Kingdom and released in 2009.
Urambie	A fast, winter, dual-purpose, feed quality barley. Early maturity combined with a cold requirement to initiate heading. Bred by NSW DPI released in 2006.

Results

Plant establishment

The mean plant population was ~83 plants/m^2. This is below the targeted 100 plants/m^2, but the establishment was even across the plots (Figure 2).

Figure 2 (a) Biomass cuts and (b) simulated grazing treatment (mowing to ~3 cm height) was conducted on cereal plots at growth stage 30 (GS30).

Biomass at growth stage 30: the start of stem elongation

Total above ground (DM) production was calculated from biomass cuts (0.5 m2) taken from the inner three rows of plots at GS30 (Figure 2a). Growth stage 30 is defined as 'when the tip of the developing ear/head on the main stem, is 1 cm from the base of the stem, where the lowest leaves attach to the shoot apex' (GRDC Cereal growth stages guide 2005).

Grazing is commonly terminated at GS30, to prevent the removal of developing heads, tiller death and hence potential loss of grain yield. The grazing treatments were applied directly after GS30 biomass data was collected (Figure 2b), and no significant difference was recorded between the grazed (orange line) and non-grazed (blue line) treatments (Figure 3).

GS30 biomass production ranged from 5.5 t DM/ha for Cassiopee from SD2, down to 1.10 t DM/ha for Sunlamb⁽ᴰ⁾ from SD3.

The days taken to reach GS30 varied considerably between varieties and ranged from 35 days for Oxford up to 108 days for RGT Calabro, reflecting differences in phenology and maturity type and response to sowing dates.

The slower maturing winter types take longer to reach GS30, resulting in a longer grazing period and higher DM production compared with other varieties evaluated. The results do not fully capture the effective grazing period, as these varieties are initially slow to grow, and therefore accumulate more DM later in the season. In contrast, quicker maturing varieties would have a reduced length of grazing.

The slower maturing winter wheats, RGT Accroc and RGT Calabro, and the winter barley Cassiopee generally took longer to reach GS30 compared with other varieties, but accumulated more biomass (Table 2). These three varieties produced >4.0 t DM/ha across all three sowing dates. Einstein, another slow maturing winter wheat produced >4.0 t DM/ha from SD1 and SD2 (Table 2).

The long-season, winter habit triticale, Cartwheel⁽ᴰ⁾, also accumulated high amounts of DM (>4.0 t DM/ha for SD1 and SD2).

The AH wheat, Illabo⁽ᴰ⁾ was the best performed Australian bred winter wheat, producing 4.18 t DM/ha from SD1 and 3.91 t/ha from SD2 (Table 2).

Varieties such as Illabo⁽ᴰ⁾ underline the importance of timely sowing, to ensure enough time for DM accumulation. When sowing was delayed (SD3), there was significantly less DM produced.

Similarly, the slow spring variety, Sunlamb⁽ᵖ⁾, highlighted the importance of sowing date on DM production. It was better suited to an early April sowing (SD2) opposed to a mid-March (SD1) sowing to optimise DM accumulation.

Table 2 Grain yield, biomass and maturity data summary for 15 cereal varieties with grazing (G) and non-grazing (NG) treatments at three sowing dates (SD1:13 March, SD2: 2 April, SD3: 23 April) at Tamworth 2020.

Variety	SD	Yield at 11% (t/ha)		GS30 DM (t/ha)		GS65 DM (t/ha)		Days to F50		Days to GS30
Grazing treatment:		NG	G	NG	G	NG	G	NG	G	
Barley										
Cassiopee	1	3.72	3.69	4.67	3.82	9.84	10.61	192	192	100
	2	4.81	4.51	5.49	4.86	10.27	9.53	168	186	89
	3	4.32	3.98	4.47	5.12	10.61	9.35	153	158	96
Oxford	1	2.22	3.40	1.21	1.44	12.46	10.57	197	188	35
	2	4.59	5.72	1.76	2.02	15.92	12.94	177	183	42
	3	5.25	5.59	1.96	1.83	13.15	10.92	157	149	55
Urambie	1	4.52	5.09	2.81	3.04	12.55	11.13	186	189	59
	2	4.56	5.46	3.70	3.92	11.72	11.81	157	166	60
	3	5.31	5.54	1.69	1.55	11.82	11.22	149	158	58
Triticale										
Cartwheel	1	3.53	4.47	4.42	4.66	11.31	8.91	185	193	91
	2	7.25	5.56	4.02	4.85	10.98	8.49	169	173	91
	3	7.68	6.35	3.87	3.82	10.89	6.76	156	138	96
Endeavour	1	4.07	4.97	3.11	2.68	13.87	12.19	201	194	60
	2	5.74	5.89	2.38	2.36	12.30	12.29	186	185	52
	3	5.18	4.98	2.28	2.63	13.52	10.88	162	161	71
Wheat										
DS Bennet	1	3.36	4.67	1.51	1.80	16.49	15.16	184	310	50
	2	4.34	6.14	2.63	2.70	14.23	13.11	162	166	52
	3	4.82	5.77	2.35	1.98	11.97	10.53	163	154	71
EGA Wedgetail	1	4.39	4.97	2.00	2.38	14.50	11.89	199	199	56
	2	5.17	5.58	3.72	3.76	11.38	10.02	178	168	65
	3	5.72	6.02	2.18	2.39	9.36	10.43	157	156	73
Einstein	1	6.45	6.01	4.11	3.55	14.62	12.84	196	200	80
	2	6.81	6.06	4.11	4.85	16.39	11.95	181	180	85
	3	6.27	6.19	3.01	3.35	13.68	11.58	160	152	91
Illabo	1	3.42	4.51	3.80	4.18	14.71	10.59	188	197	75
	2	4.39	5.42	3.91	3.48	12.45	11.38	184	181	68
	3	5.91	6.59	2.05	2.14	11.81	11.30	152	167	75
LongReach Kittyhawk	1	4.43	4.77	2.49	2.41	11.19	13.84	195	192	50
	2	4.90	5.87	2.65	2.37	11.98	11.45	189	186	55
	3	5.49	5.76	1.55	1.75	12.28	9.57	162	159	65
LongReach Nighthawk	1	1.00	1.81	1.81	1.45	11.35	12.16	178	199	51
	2	3.66	4.52	2.63	2.54	14.15	12.13	171	175	50
	3	6.20	6.67	1.47	1.55	13.34	11.75	159	153	65

Variety	SD	Yield at 11% (t/ha)		GS30 DM (t/ha)		GS65 DM (t/ha)		Days to F50		Days to GS30
Grazing treatment:		**NG**	**G**	**NG**	**G**	**NG**	**G**	**NG**	**G**	
Manning	1	4.43	4.81	2.40	2.32	12.85	11.56	200	195	63
	2	5.25	5.26	3.59	3.29	13.34	12.60	170	160	64
	3	4.61	5.40	2.16	1.73	12.36	11.42	149	143	76
RGT Accroc	1	5.01	6.30	4.98	5.15	13.19	12.21	191	184	87
	2	6.21	6.40	5.28	5.18	13.31	9.96	175	183	95
	3	6.12	6.48	4.24	4.42	14.96	10.90	157	145	102
RGT Calabro	1	6.21	6.64	4.88	4.45	13.97	11.89	182	202	76
	2	7.75	6.58	5.04	5.21	12.67	10.64	154	163	89
	3	7.17	6.90	4.41	4.77	15.40	9.99	148	152	108
Sunlamb	1	3.23	4.49	1.69	1.71	12.73	12.55	193	201	48
	2	5.25	6.08	2.96	3.12	14.64	11.99	161	160	46
	3	5.71	6.23	1.33	1.10	13.38	12.19	161	157	61
P-value (variety)		<0.001		<0.001		<0.001		–		–
P-value (graze)		<0.001		ns		<0.001		–		–
P-value (SD)		<0.001		0.014		ns		–		–
P-value (variety:graze)		<0.001		ns		0.005		–		–
P-value (variety:SD)		<0.001		<0.001		<0.001		–		–
P-value (graze:SD)		0.002		ns		ns		–		–
P-value (variety:graze:SD)		ns		ns		0.029		–		–

Biomass at GS65 – anthesis

Total DM production was calculated from biomass cuts (0.5 m^2) taken from the inner three rows of plots when plants reached anthesis (GS65). Sampling at GS65 was chosen as it is generally accepted that feed quality largely declines for most species following anthesis (GRDC 2018).

The amount of above ground biomass produced at GS65 for non-grazed treatments ranged from 16.5 t DM/ha for DS Bennett$^{\phi}$ from SD1, down to 9.4 t DM/ha for EGA Wedgetail$^{\phi}$ from SD3. The results highlight the high DM yield potential of DS Bennett$^{\phi}$, the spring barley Oxford, and the European winter wheats (e.g. RGT Calabro, Einstein), which were all capable of producing >15.0 t/ha (Figure 4).

The overall effect of grazing on biomass accumulation was variable, averaging a 12% decline in DM, across all varieties and sowing dates. Dry matter production declined following grazing with delayed sowing dates averaging 8% from SD1, 12.5% from SD2, and up to ~15% from SD3 averaged across varieties.

Total DM production at GS65 (after grazing at GS30), ranged from 15.2 t/ha for DS Bennett$^{\phi}$ from SD1, down to 6.8 t/ha for Cartwheel$^{\phi}$ from SD3.

Cartwheel$^{\phi}$ triticale had the greatest decrease in DM production following grazing, (38% for SD3, 0.89 t DM/ha non-grazed versus 6.76 t DM/ha grazed). The variety's declines in DM in response to grazing were ~21% and 23% for SD1 and SD2 respectively.

Other varieties that displayed large declines in DM following grazing included RGT Calabro (35% decrease from SD3), RGT Accroc (27% from SD3), Einstein 27% (SD2) and RGT Accroc with a 25% decrease (SD2).

These results highlight differences in DM yield potential of varieties both in response to SD and recovery following grazing at GS30.

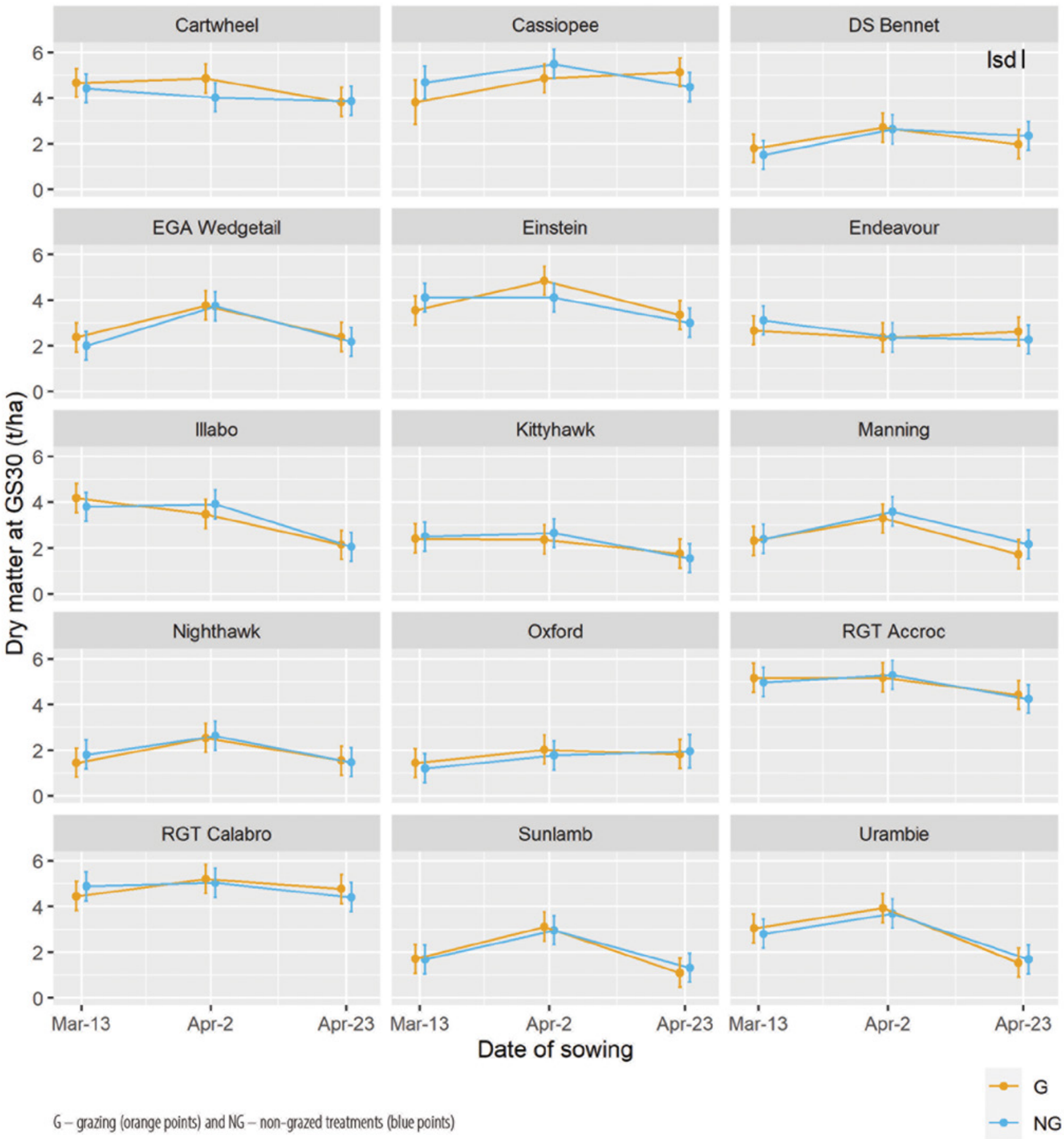

Figure 3 Dry matter production (t/ha) at GS30 for 15 cereal varieties) for three sowing dates at Tamworth 2020.

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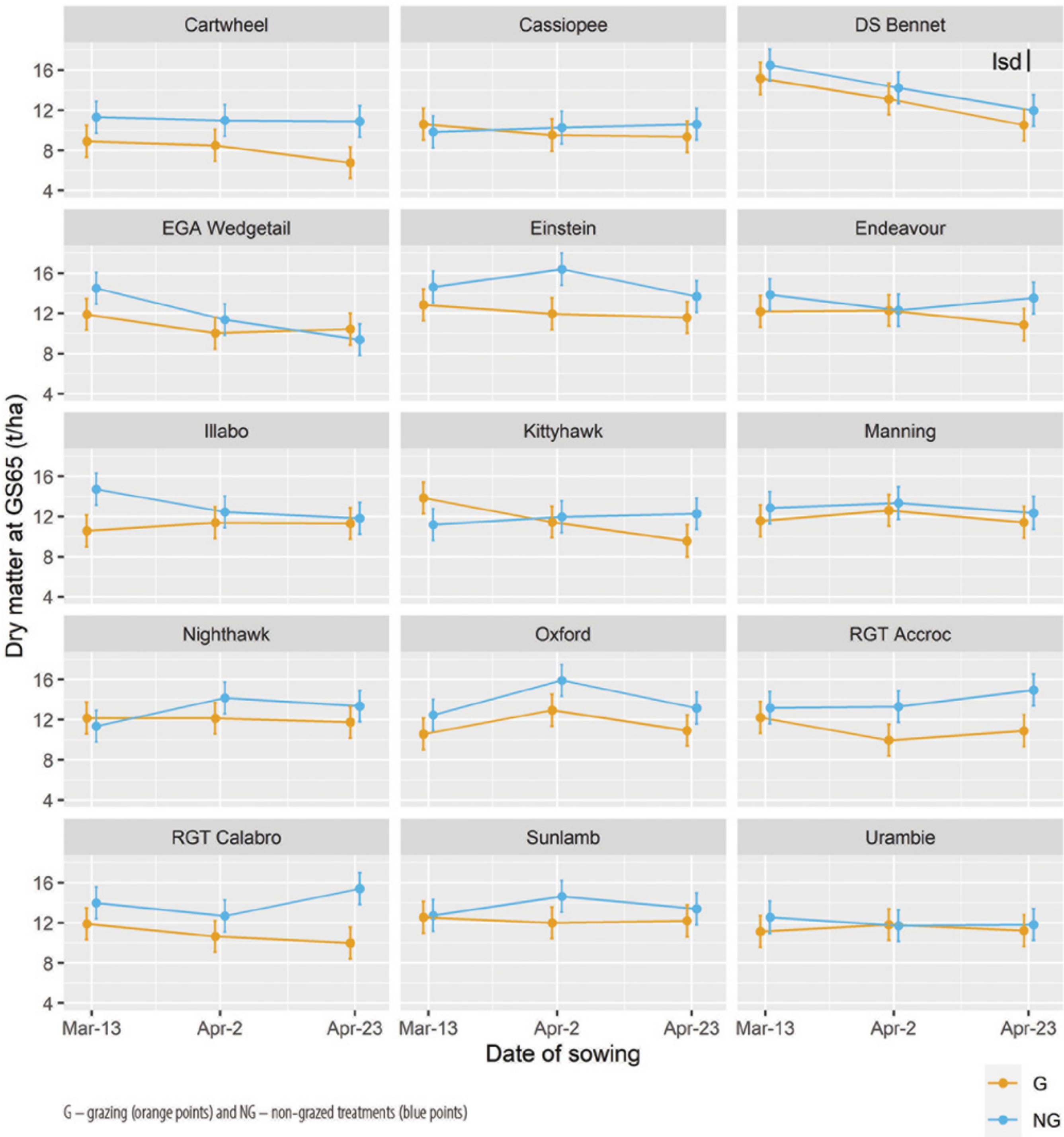


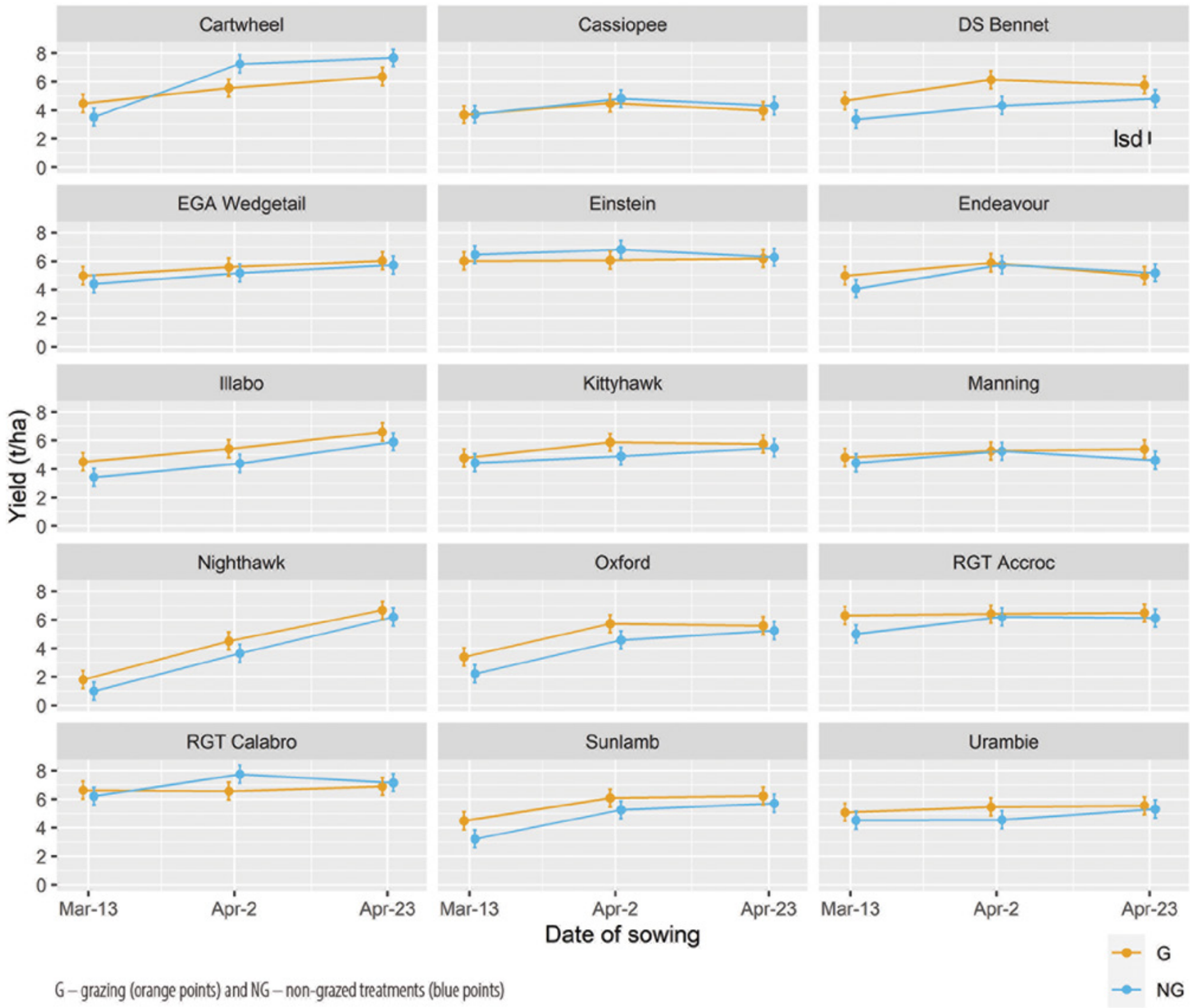
G – grazing (orange points) and NG – non-grazed treatments (blue points)

Figure 4 Dry matter production (t/ha) at GS65 for 15 cereal varieties for three sowing dates at Tamworth 2020.

Grain yield

This experiment highlighted the high yielding potential of varieties and their variable responses of yield to grazing and sowing date:

- A range of variety and sowing date combinations achieved grain yields of >6.0 t/ha, some exceeding 7.0 t/ha.
- The European varieties Einstein, RGT Accroc and RGT Calabro were all high yielding. RGT Calabro was the highest yielding variety in this experiment with >6.0 t/ha for all sowing dates for both grazed and non-grazed (Figure 5).
- RGT Calabro also had the highest individual yield in this experiment with 7.75 t/ha for the non-grazed treatment from SD2 (Table 2). Einstein achieved similar yields of >6.0 t/ha for all treatment combinations both grazed and non-grazed.
- The late-maturing varieties' ability to maintain yield from delayed sowings, particular from SD3, was probably due to good, late spring rainfall received in October.
- The triticale Cartwheel⊕ achieved comparable yields with the best performing wheats, yielding 7.68 t/ha and 7.25 t/ha respectively for the non-grazed treatments from SD2 and SD3 (Table 2).
- The results highlight the potential for yield decline with grazing. From SD2, there was a 23% yield decrease from grazing factors that could lead to yield declines following grazing including:
    - frost effects after grazing
    - poor leaf area recovery
    - delayed maturity, which can result in water and/or heat stress around anthesis and a decreased grain fill period.
- The slow, spring wheats, LongReach Nighthawk⊕ and Sunlamb⊕ and mid to slow barley Oxford, had positive yield responses to grazing when sown early (SD1), but these positive responses declined with later sowing dates. These yield responses to grazing from the early sown spring types (i.e. SD1), was the result of delayed anthesis, leading to frost avoidance (grazing versus non-grazed).
- Varieties such as DS Bennett⊕ showed a positive yield response to grazing across all sowing dates, with grazing at GS30 producing a yield increase of >20% compared with the non-grazed (Figure 5).
- The milling quality winter wheats, Illabo⊕, EGA Wedgetail⊕ and LongReach Kittyhawk⊕, were also high yielding, with Illabo⊕ the best at 6.59 t/ha (grazed SD3). This yield reflects the late October rainfall.
- The very slow spring wheats, LongReach Nighthawk⊕ and Sunlamb⊕, achieved yields ≥6.0 t/ha.
- The best performed barleys were lower yielding than the better performing wheat and triticales. The mid to slow spring variety Oxford was the best performer, yielding 5.72 t/ha from the SD2 grazing treatment.



G – grazing (orange points) and NG – non-grazed treatments (blue points)

Figure 5 Grain yield (t/ha) for 15 cereal varieties at three sowing dates at Tamworth 2020.

Grain quality

Grain quality classifications and/or receival standards can limit a variety's marketing options. A wheat variety cannot be marketed above its maximum grain quality classification. Wheat varieties evaluated in this experiment included APH, AH, ASW and Feed classified wheats. The decreasing order of grain quality classifications is APH>H>APW>ASW>Feed. If a variety is able to be delivered into a higher grain quality bracket or grade (e.g. APH or H1), it will attract a price premium and the potential for overall returns will be greater.

Grain quality parameters and classifications detailed in Grain Trade Australia (GTA) trading standard (GTA 2020) guidelines were used to define quality. Screenings (% material by weight, below 2.0 mm screen) >5% was one parameter resulting in the grain being downgraded.

- LongReach Kittyhawk was downgraded from APH to AUH for some delayed sowing treatments (Table 3). Due to LongReach Kittyhawk's superior milling quality, (unlike lower grade feed varieties) it could still be marketed as a higher value grade as Australian Utility White (AUH; screenings of between 5% and 10%).
- Later sowing dates and/or grazing + later sowing dates, increased screenings in LongReach Kittyhawk$^{\phi}$ and in Sunlamb$^{\phi}$ for some treatments.

- Grain protein concentration for APH/AH classified wheats ranged from 15.05% for Illabo$^{\phi}$ (yielding 3.42 t/ha, non-grazed, SD1), down to 11.85% for LongReach Kittyhawk$^{\phi}$ (5.87 t/ha, grazed, SD2) These differences in grain protein content are related to the yield dilution effect, that is that yield and protein are inversely proportional.
- Only two of the milling quality wheats, EGA Wedgetail$^{\phi}$ (non-grazed, SD3) and Illabo$^{\phi}$ (non-grazed, SD1) were downgraded as a result of a low test weight <76 kg/hL.
- All of the Feed wheats in this experiment exceeded the minimum test weight of ≥62 kg/hL, and were below the maximum allowed screenings of <15%.
- The three barley varieties evaluated were Feed classified (not Australian malt accredited). Oxford achieved Feed1 (GTA, 2020) for all treatments, apart from SD1 non-grazed and SD3 grazed. In contrast, Urambie$^{\phi}$ was primarily classified as Feed2 due to low test weights and/or high screenings (test weight <62.5 kg/hL and/or screenings >15%).
- The French winter barley, Cassiopee, failed to achieve test weight standards for Feed1, apart from the SD3, downgrading it to Feed2 and Feed3.
- Based on the GTA Triticale Standards 2020/21 (GTA 2020), the two varieties evaluated met the receival standards for test weight of >65.0 kg/hL and were below maximum allowable screenings of 10.0% for all treatments.
- Triticale has no specified minimum grain protein concentration for delivery, but in this experiment it ranged from 13.9% for Endeavour (SD1; non-grazed) down to 9.8% for Cartwheel$^{\phi}$ (SD2 grazed) (Table 3).

Table 3 Grain quality parameters of 15 cereal varieties for grazing and non-grazing treatments at three sowing dates (SD1: 13 March, SD2: 2 April, SD3: 23 April) at Tamworth 2020.

Variety	SD	Seed weight (g/1000 grains)		Screenings (%)		Protein content (% DMB)		Test weight (kg/hL)	
Grazing treatment:		NG	G	NG	G	NG	G	NG	G
Barley									
Cassiopee	1	35.92	34.60	9.51	9.62	14.97	11.43	60.33	58.67
	2	33.17	35.08	7.53	6.22	16.23	11.93	61.67	60.10
	3	40.01	38.85	3.77	3.61	17.27	13.80	64.07	63.73
Oxford	1	33.47	40.89	12.74	3.76	15.17	14.17	60.77	66.23
	2	37.20	34.09	5.11	5.71	14.37	13.60	67.00	65.63
	3	35.89	31.79	11.07	24.13	14.60	14.47	66.47	62.80
Urambie	1	37.76	35.76	9.61	12.24	13.70	11.83	61.20	60.73
	2	36.85	34.03	10.94	15.03	14.70	11.83	61.90	61.37
	3	42.96	38.47	7.71	16.23	15.23	14.07	65.77	63.13
Triticale									
Cartwheel	1	33.32	27.67	2.44	4.23	12.70	11.57	72.75	70.99
	2	29.73	31.84	4.00	3.71	11.50	9.77	73.72	73.03
	3	31.37	32.39	4.62	4.75	12.87	10.20	70.53	71.13
Endeavour	1	41.01	36.36	1.89	1.99	13.87	11.73	67.61	68.13
	2	36.76	31.53	2.79	4.04	13.00	11.47	69.13	69.40
	3	35.01	36.03	3.44	3.33	13.77	12.57	69.17	69.87

Variety	SD	Seed weight (g/1000 grains)		Screenings (%)		Protein content (% DMB)		Test weight (kg/hL)	
Grazing treatment:		NG	G	NG	G	NG	G	NG	G
Wheat									
DS Bennett	1	33.96	34.64	4.38	3.74	13.16	11.93	80.40	81.43
	2	32.84	34.63	7.22	5.80	12.16	10.89	81.20	81.70
	3	34.89	36.04	8.77	6.15	12.43	11.73	79.33	78.57
EGA Wedgetail	1	35.32	33.33	2.40	2.69	14.44	13.83	77.57	78.10
	2	31.77	33.43	4.29	3.92	13.73	11.70	77.77	78.30
	3	31.88	33.65	4.99	4.42	13.57	12.87	75.87	76.70
Einstein	1	31.99	35.15	5.18	5.01	11.98	10.98	76.57	76.47
	2	34.91	37.32	6.11	4.61	11.58	9.67	72.03	70.90
	3	31.77	30.97	6.71	5.08	12.43	12.00	74.67	75.87
Illabo	1	37.00	36.89	2.51	2.51	15.05	13.05	75.67	78.70
	2	33.53	37.33	3.09	2.56	14.77	12.49	77.40	79.67
	3	36.15	32.83	3.15	4.44	13.73	12.27	77.00	77.30
LongReach Kittyhawk	1	39.24	36.79	3.55	3.11	13.58	12.91	82.97	83.50
	2	37.69	32.81	4.59	6.01	13.01	11.85	83.40	82.73
	3	34.57	34.28	5.60	5.32	13.10	12.83	81.07	80.67
LongReach Nighthawk	1	31.69	34.97	3.95	2.44	17.68	16.25	72.94	74.87
	2	32.21	34.31	3.29	2.77	14.54	13.37	77.33	80.13
	3	37.00	35.17	3.92	3.50	13.07	12.23	81.77	82.40
Manning	1	37.64	35.77	5.93	5.18	11.91	11.46	76.50	76.10
	2	37.23	34.03	4.66	4.68	10.90	10.44	67.83	69.23
	3	32.49	33.40	6.85	6.42	12.07	11.50	73.93	76.20
RGT Accroc	1	35.28	37.00	4.96	4.07	12.23	10.09	79.03	79.57
	2	36.89	37.96	5.88	6.21	11.19	8.32	79.87	78.90
	3	35.75	39.56	4.36	4.90	12.53	9.70	78.03	79.60
RGT Calabro	1	39.12	39.00	5.67	6.07	12.73	10.89	80.47	81.10
	2	45.37	41.88	4.26	6.90	12.12	10.16	79.50	81.20
	3	42.87	40.81	5.28	6.25	12.27	12.30	81.70	82.07
Sunlamb	1	31.92	32.40	2.43	2.54	15.77	15.10	79.37	79.80
	2	32.45	32.43	3.06	3.76	14.40	12.84	80.77	81.60
	3	33.57	32.05	7.08	7.48	13.07	13.20	81.37	80.10
P-value (variety)		<0.001		<0.001		<0.001		<0.001	
P-value (graze)		ns		ns		<0.001		ns	
P-value (SD)		ns		ns		ns		ns	
P-value (variety:graze)		<0.001		<0.001		<0.001		ns	
P-value (variety:SD)		<0.001		<0.001		<0.001		<0.001	
P-value (graze:SD)		ns		0.003		0.006		ns	
P-value (variety:graze:SD)		<0.001		<0.001		ns		ns	

Feed value analysis

The DM cuts from SD 1 at GS30 and GS65 were analysed for feed quality. A bulked sample was prepared for each variety from the three field replicates and analysed at the NSW DPI Feed Testing Laboratories at Wagga Wagga.

Important feed quality traits include neutral detergent fibre (NDF), ME and CP. Neutral detergent fibre is a measure of a plant's structural, slowly digested cell wall components. It includes hemicellulose, cellulose and lignin or 'indigestible fibre'. As the percentage of NDF increases, animal intake tends to decline due to increasing fibre content, which takes longer to digest in the rumen. It is also important that NDF values are not too low (i.e. <30%) to avoid stomach upsets such as acidosis. Conversely, high NDF values (i.e. >60%) can affect digestibility, limiting intake.

- Feed quality results for grazing samples taken at GS30 were within the recommended NDF values of 30–60%.
- Values for NDF ranged from 46% for Oxford up to 52% for RGT Calabro (Table 4).
- The ME of the forage taken at GS30, ranged from 11.6 MJ/kg to 13.4 MJ/kg satisfying the dietary requirements of most sheep and cattle. The results indicate that lower fibre diets (i.e. less mature plant material) are more digestible and higher in ME.
- Crude protein levels for early grazing ranged from 20.2% to 27.4%. It is important to note that CP includes both true protein and non-protein nitrogen (NPN) and doesn't differentiate between nitrates and proteins in plants. Nitrate concentrations are usually higher in younger plants and decline as plants mature. High nitrate levels can be an issue when grazing young cereal crops and producers should exercise caution and contact their veterinarian or Local Land Services livestock officer prior to grazing to discuss any potential animal health and/or management issues.
- Feed analysis for DM cuts taken at GS65 showed that NDF values increased and DM digestibility decreased as crops matured. Neutral detergent fibre values ranged from 52% for EGA Wedgetail$^{\phi}$, Einstein, LongReach Nighthawk$^{\phi}$ and RGT Calabro, up to 60% for LongReach Kittyhawk$^{\phi}$ (Table 4).
- The ME ranged from 7.4 MJ/kg for LongReach Kittyhawk$^{\phi}$ up to 10.1 MJ/kg for Cassiopee, with CP ranging from 7.5% for Manning$^{\phi}$ up to 16.5% for EGA Wedgetail$^{\phi}$.
- Based on AFIA standards for cereal hay, Cassiopee barley achieved the highest A1 grade. LongReach Kittyhawk$^{\phi}$ produced the lowest grade of D2.

Table 4 Feed quality analysis (DM basis) of wheat, barley and triticale at GS30 and GS65 for SD1, sown on 13 March at Tamworth 2020.

Variety	Growth stage	Near infrared (NIR) spectrophotometry analysis									AFIA cereal hay grade* (GS65 only)
		ADF (%)	ASH (%)	CP (%)	DMD (%)	DOMD (%)	ME (MJ/kg DM)	NDF (%)	OM (%)	WSC (%)	
Barley											
Cassiopee	GS30	31	10	24.2	81	75	12.3	51	90	11.9	–
	GS65	29	9	11.8	68	64	10.1	55	91	13.8	A1
Oxford	GS30	26	13	27.4	88	81	13.4	46	87	11.5	–
	GS65	31	9	15.3	61	59	8.9	55	91	10.7	B1
Urambie	GS30	27	14	24.6	82	77	12.6	49	86	11.3	–
	GS65	29	8	11.2	65	62	9.5	54	92	16.6	B1
Triticale											
Cartwheel	GS30	23.8	11	20.2	83	77	12.6	47	89	17.9	–
	GS65	29	8	9.6	59	57	8.5	56	92	17.4	C2
Endeavour	GS30	26	13	24.3	82	77	12.5	49	88	11.0	–
	GS65	26	9	14.6	63	60	9.2	53	91	14.9	B1
Wheat											
DS Bennet	GS30	28	13	24.0	83	77	12.7	49	87	13.0	–
	GS65	32	9	10.3	58	56	8.4	58	91	13.9	C1
EGA Wedgetail	GS30	28	13	22.7	81	76	12.4	49	87	11.6	–
	GS65	28	10	16.5	64	61	9.5	52	90	13.2	B1
Einstein	GS30	27	12	25.4	83	77	12.6	50	88	9.4	–
	GS65	28	9	13.2	66	63	9.7	52	91	18.0	A1
Illabo	GS30	30	13	22.1	77	72	11.6	51	87	11.5	–
	GS65	29	10	10.3	60	58	8.7	58	90	18.8	B1
LongReach Kittyhawk	GS30	28	9	22.6	80	75	12.2	49	88	12.6	–
	GS65	32	9	9.0	52	51	7.4	60	91	9.9	D2
LongReach Nighthawk	GS30	28	14	24.2	82	76	12.5	50	87	12.3	–
	GS65	27	8	12.8	65	62	9.6	52	92	18.8	B1
Manning	GS30	27	13	24.7	84	78	12.9	49	87	11.8	–
	GS65	26	8	7.5	66	63	9.7	53	92	24.3	A3
RGT Accroc	GS30	28	13	21.4	79	74	12.0	51	87	13.1	–
	GS65	31	10	9.6	60	58	8.8	56	90	13.7	B2
RGT Calabro	GS30	28	12	22.1	78	73	11.7	52	88	9.6	–
	GS65	29	9	9.0	62	59	9.1	54	91	20.3	B2
Sunlamb	GS30	28	14	23.4	82	76	12.5	51	86	13.2	–
	GS65	29	8	10.4	61	59	8.9	53	92	18.8	B1

ADF – acid detergent fibre (%) ASH – ash (%) CP – crude protein (%)
DMD – dry matter digestibility (%) DOMD – digestibility of the organic matter contained in the dry matter (%) ME – metabolisable energy (MJ/kg DM)
NDF – neutral detergent fibre (%) OM – organic matter (%) WSC – water soluble carbohydrates (%)

* Australian Fodder Industry Association (AFIA) standards for cereal hay (https://graintrade.org.au/sites/default/files/file/Commodity%20Standards/Section%2005%20-%20Fodder%20201112.pdf), which consider DMD, ME and CP when grading hay and silage. Under this system the highest grade A1, has an ME >9.5 MJ/kg, DMD >66% and CP% >10, whereas the lowest grade D4 has an ME <7.5 MJ/kg, CP <4% and DMD <53%. Lower letters (i.e. D) indicating lower ME and/or DMD higher numbers (i.e. 4) an indicator of lower CP% (Fodder Standards, 2011/12).

Conclusions

The factors to consider when selecting a dual-purpose cereal are:

- the ability of a variety to produce forage for opportunistic grazing and/or to fill a feed gap
- to recover and yield good quality grain that can be delivered into higher priced markets.

Where livestock production is an integral component of the farming system, total forage production and DM timing production are important varietal selection criteria. Disease resistance, particularly to leaf and stripe rust, needs also to be considered.

The issue confronting growers is which variety is the best option. This needs to take into account the purpose of the crop (grain versus graze versus grain and graze), sowing date timing and marketing opportunities.

Biomass at GS30

The time taken to reach GS30 varied considerably in this experiment:

- GS30 ranged from 35 days for Oxford up to 108 days for RGT Calabro, due to differences in phenology and responses to sowing date and the effective potential grazing period length.
- The slower maturing European winter wheats, RGT Accroc, RGT Calabro, and the winter barley Cassiopee were the best performing varieties in terms of DM production at GS30, producing >5.0 t DM/ha.
- Other varieties that accumulated high biomass at GS30 included Einstein and Illabo$^{\phi}$ wheat, and Cartwheel$^{\phi}$ triticale, producing >4.0 t DM/ha (SD1 and/or SD2).

These variety responses underline the importance of timely sowing opportunities to ensure sufficient time for biomass accumulation.

The slower maturing varieties, taking longer to reach GS30, offer an extended grazing period. The results, however, do not fully capture the effective grazing period, as these varieties are initially slow to grow, meaning they tend to accumulate more biomass later in the season. Quicker maturing varieties would produce less biomass at GS30, but earlier in the growing season.

These are factors to consider when selecting a variety to meet a feed gap and/or optimise DM production at GS30.

Biomass at GS65

Several varieties accumulated >15 t DM/ha for non-grazed treatments at GS65 including Oxford barley and the winter wheats DS Bennett$^{\phi}$, Einstein, RGT Accroc and RGT Calabro. These results indicate their potential as forage hay/silage options.

DS Bennett$^{\phi}$ from SD1 was the highest yielding of the non-grazed treatments (16.5 t DM/ha at GS65).

This experiment highlighted differences in feed/hay quality between varieties, with Einstein, achieving an AFIA hay grading of A1 compared with a hay grade of D2 for LongReach Kittyhawk$^{\phi}$, at the same growth stage.

Biomass at GS65 response to grazing

There was an average of a 12% decline in biomass production from grazing at GS30 on subsequent biomass accumulation at GS65, across all varieties and sowing dates.

Dry matter production following grazing at GS30 also tended to decline with later sowing dates, averaging 8% for SD1, 12.5% for SD2 and up to ~15% for SD3 averaged across varieties.

- DS Bennett$^{\phi}$ from SD1 was the least affected by grazing GS30, performing the best (15.2 t DM/ha at GS65).
- Cartwheel$^{\phi}$ performed the worst with DM production decreasing 38% following grazing (10.9 t DM/ha non-grazed versus 6.76 t DM/ha grazed).

Grain yield

RGT Calabro and Cartwheel$^{\Phi}$ both achieved excellent yields of >7.0 t/ha from SD2 and SD3 (non grazed).

Following grazing, the best performed varieties for DM at GS30 and subsequent grain yield were the Feed winter wheats.

- Both RGT Calabro and RGT Accroc produced >5.0 t DM/ha at GS30 and yielded >6.4 t/ha of grain, from a 2 April sowing date (SD2).
- Cartwheel$^{\Phi}$ triticale was also high yielding, (6.4 t/ha for SD2), but it was slightly lower in terms of DM production at GS30 at ~3.8 t/ha.
- The higher quality AH milling wheat, Illabo$^{\Phi}$, was high yielding at ~6.6 t/ha, but only produced 2.1 t DM/ha at GS30.

There were variable yield responses to grazing at GS30. Varieties such as DS Bennett$^{\Phi}$, Illabo$^{\Phi}$ and Oxford for example, showed positive yield response to grazing. Possible reasons for responses include reduced lodging and delayed phenology (i.e. frost avoidance at anthesis).

- Cartwheel$^{\Phi}$ suffered a yield penalty of 17–23% following grazing compared with non grazed, possibly due to frost effects soon after grazing and delayed maturity, which can result in water and/or heat stress at anthesis or grain fill.

Note that these results presented are for one season only and the ability of late maturing varieties to maintain yield from delayed sowings particularly from SD3, reflects the favourable, late spring rainfall received in October 2020. This should to be taken into consideration when selecting a variety and sowing date option.

Grain quality

Grain quality receival standards and the ability of a variety to be delivered into a higher priced market are important considerations regarding varietal selection.

The two highest yielding grazed AH varieties, Illabo$^{\Phi}$ and EGA Wedgetail$^{\Phi}$ in SD3, both achieved an H2 classification.

Both RGT Calabro and RGT Accroc were high yielding, but are only Feed wheats and would both receive a considerable price discount compared with milling wheats. Likewise, grain receival prices for both feed barley and triticale would also be assumed to be considerably lower than that of higher-grade milling quality wheats, affecting returns.

Growers on the north-western slopes of NSW have access to a range of early sowing date, dual-purpose crops and varieties that can provide valuable winter forage for livestock, while also potentially achieving high yield.

Preliminary results from this experiment, indicate that the feed quality wheats RGT Calabro, RGT Accroc and Einstein offer growers both good grazing potential at GS30 and high grain yield potential. Likewise, the triticale variety Cartwheel$^{\Phi}$ was shown to provide good winter forage production at GS30 and was also high yielding. Other varieties that performed well included the AH classified milling quality wheats Illabo$^{\Phi}$ and EGA Wedgetail$^{\Phi}$.

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